Structure and function of body organs

15. Cholesterol-containing foods for children and adolescents: recommendations catching up with research

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Abstract

The world's obesity problem has many causes, although energy intake is always higher than output with excess stored as fat. Between 1976 and 2003, obesity in children 6-19 years in the US increased from 5-7% to 16-21%. Consequences of obesity are related to inflammation, oxidation, and adipocyte function, the latter a primary reason for loss of appetite control and increased blood glucose and blood pressure. Dietary intake is not the only cause, but controlling intake of low-nutrient-dense high-energy-dense foods must be part of the answer. Cholesterol-containing foods, restricted in part because of misinterpretation of research data decades ago, included eggs, dairy foods (even low-fat) ones, and red meat. Food intake by children and adolescents from NHANES 2003-2006 showed that 18% of energy came from baked goods, sugared soft drinks, and candy/sugary foods while 16% energy was provided by milk, eggs, and meat. Nutrients from the latter groups include vitamin D, calcium, potassium, vitamin A, vitamin E, and iron, all of which are deficient in diets in the USA (shortfall), plus other nutrients. Research indicates that bioactive compounds and high quantities of many nutrients in milk result in benefits ranging from less inflammation to less adipose tissue in adolescents. Eggs have the highest quality protein available with carotenoids to prevent macular degeneration plus docosahexanoic acid (DHA), choline, and several deficient nutrients. However, decades of warnings not to eat them worked. Lean meat provides key nutrients in a low-energy form, including high quality protein and bioactive peptides most of which have an antihypertensive effect. Most studies show that lean meat either decreases risk of type 2 diabetes mellitus and cardiovascular disease or has no effect. Fish and shellfish (not fried) can provide a plethora of nutrients, not the least of which is marine oils, DHA and eicosapentanoic acid. Parenting style and modeling the behaviors that they encourage can impact food choices of children. Encouraging intake of cholesterol-containing foods can improve nutritional health of children and adolescents.

Keywords: childhood obesity, eggs, milk, meat, dietary guidelines

R.R. Watson and F. De Meester (eds.) Handbook of **cholesterol**
Human Health Handbooks no. 11 – DOI 10.3920/978-90-8686-821-6_15, © Wageningen Academic Publishers 2016

Key facts

- More than one in six children and adolescents in the USA is obese (15% more overweight) with a higher risk of diabetes, hypertension, cardiovascular disease (CVD), and other problems in the future.
- Milk is the most important source of vitamin D, calcium, potassium, and vitamin A for children and adolescents in the USA.
- Egg provides the best protein in our diet, lots of nutrients, and lutein and zeaxanthine for eye health. Cholesterol in the diet has little effect on blood cholesterol or coronary heart disease (CHD) so enjoy your eggs.
- Lean beef and pork provide excellent protein, potassium, iron, zinc, and vitamin B_{12} for children and adolescents with relatively few kcal; but processed meat may increase risk of CHD and type 2 diabetes mellitus (T2DM).
- Fish has excellent protein, docosahexanoic acid and eicosapentanoic acid for cardiovascular health, and bioactive compounds to prevent hypertension plus lots of other nutrients, including the antioxidant selenium.

Summary points

- In 1976-80 5-7% of children and adolescents were obese (excess fat), but now almost 20% are in that group and have a higher risk of chronic disease as adults.
- Research shows that almost 20% of calories consumed by children and adolescents came from bakery products, sweetened soft drinks, and candy and other sugar with few if any nutrients.
- Milk, eggs, fish, and lean meat are excellent sources of high quality protein and nutrients that are important to prevent health problems, including vitamin D, calcium, potassium, magnesium, and iron.
- Milk, eggs, and lean meat contain cholesterol, a substance that has been shown to have little if any effect on either blood lipids of most people or development of CVD.
- Biologically active substances in milk have been shown to reduce blood pressure, increase sensitivity to insulin, decrease fat synthesis, reduce hunger, and much more.
- If cholesterol in the diet usually increases low-density lipoprotein-cholesterol or 'bad cholesterol', high-density lipoprotein-cholesterol or 'good cholesterol' increases as well so the balance or ratio stays the same, which is beneficial.
- Dietary cholesterol may have more impact on diabetics than those who have normal glucose tolerance so caution recommending higher intake is warranted.
- Lean beef and pork have been reported to help to prevent or have no effect on development of T2DM and CVD, but processed beef and pork increase risk of these problems significantly.

Abbreviations

BMI	Body mass index
CHD	Coronary heart disease
CVA	Cerebrovascular accident (stroke)
CVD	Cardiovascular disease
DGA	Dietary Guidelines for Americans
DHA	Docosahexanoic acid
EPA	Eicosapentanoic acid
HTN	Hypertension
HDL-C	High-density lipoprotein-cholesterol
LDL-C	Low-density lipoprotein-cholesterol
NHANES	National Health and Nutrition Examination Survey
SAT	Subcutaneous adipose tissue
TC	Total cholesterol
TNF-α	Tumor necrosis factor-alpha
T2DM	Type 2 diabetes mellitus
USDA	United States Department of Agriculture
VAT	Visceral adipose tissue

15.1 Introduction

For the first time in history the need for family members to spend most of each day finding adequate food that is palatable, energy-dense and adequate to meet their needs does not exist (Birch and Doub, 2014; Popkin, 2001; Popkin *et al.*, 2001). Availability of abundant food is the standard in developed countries and many developing ones while the demands of physical activity for many tasks of daily life, including obtaining and preparing food, has declined precipitously (Popkin, 2001). Thus overnutrition and obesity, the product of long term excess energy intake as compared to energy output, have become primary concerns worldwide.

A number of people in developed countries have changed their perceptions of foods and their healthfulness, including those who adopted vegetarianism or veganism. This has led to a decline in the consumption of high-nutrient animal foods, including milk and dairy products, meat, poultry, fish, and eggs. Unfortunately, replacement foods from the ever-changing marketplace of new food products may be less nutrient-dense and more energy-dense. No question exists about the value of vegetables, fruits, whole grains, and other plant-based foods for nutrition and health. However, for those who eat animal-source foods inclusion of appropriate milk and milk products, meat, poultry, fish, and eggs helps ensure nutritional adequacy and provides health benefits as well.

In the United States periodic nationwide surveys of food consumption and health (NHANES) have provided data since 1971 (replacing the 1960's surveys of height and weight only). Reported by the Centers for Disease Control, prevalence of overweight and obesity in the USA increased remarkably between the surveys conducted in 1976-1980 and 2003-2004, but has remained relatively stable since 2008-2009 (Ogden *et al.*, 2014). According to the 2011-2012 survey, one-third of adults and 17% of children were categorized as obese (children – BMI ≥95th percentile). In addition to obesity, another 15% of children 2-19 years of age are in the overweight category (85th-94th percentile), at risk for crossing over into obesity (Ogden *et al.*, 2014).

Since 1980, Dietary Guidelines for Americans have been published to provide recommendations on dietary intake based upon information on dietary quality and health from NHANES and other sources. The 2015 DGAs will be released within a few months. A preliminary report that provides data, which are being used by the Dietary Guideline Advisory Committee to formulate dietary recommendations, was released a few months ago (Dietary Guidelines Advisory Committee, 2015). Within the report is a list of shortfall nutrients, those which are present at inadequate levels in the diets of large numbers of people, and dietary components that are overconsumed, sodium and saturated fat. The 2015 Scientific Report also defines a healthy diet as one that includes, among other things, low/non-fat dairy. Such a diet also includes less red and processed meat. Concern exists that the expected recommendations could adversely affect current intake of important nutrients in an effort to achieve recommendations for dietary components, such as type of dietary fat (Phillips *et al.*, 2015). Balancing this with concerns about health of Americans, particularly obesity but especially obesity in youth, presents significant challenges to the DGA Advisory Committee.

Obesity is a condition that is considered to be a risk factor for a variety of chronic diseases, including T2DM, HTN, and dyslipidemia, leading to CVD. The pathogenesis of such diseases occurs over a period of years sometimes decades. The concept of one-sixth of the children and adolescents in this country having a high risk of developing these diseases during young adulthood if not before is disquieting. This is of particular concern since up to 85% of obese children are likely to become obese adults thus perpetuating conditions favorable for pathogenesis of co-morbidities (Dietz, 1998). While a myriad of causes of the shocking increase in BMI in the USA have been implicated, dietary intake is a consistent focus.

Following is a discussion of obesity in youth and the value of animal products, specifically milk, eggs, and meat, to improve the nutrient adequacy of the diet and health of children and adolescents in the USA.

15.2 Obesity and its weighty consequences

Table 15.1 illustrates the increase in frequency of obesity (≥95th percentile of CDC Growth Charts) in children and adolescents since 1976. Media attention about the reasons for this essentially worldwide epidemic has focused on food marketing with widespread availability of large portions of inexpensive energy-dense foods and on reductions in physical activity related to the 'built environment' or other institutional decisions, such as decreasing physical education in schools

(McAllister *et al.*, 2009). All obesity results from a positive energy balance although a variety of other intriguing aspects of the surge in prevalence of excess adiposity are being investigated. Examples are developmental programming related to overnutrition and undernutrition during pregnancy, certain infectious agents, sleep deprivation, and effects of medications and other chemicals (McAllister *et al.*, 2009). Diets of children and adolescents in the USA include many foods that are high energy/low nutrient-density. Analysis of food sources of energy and nutrients for children and adolescents based upon data from NHANES 2003-2006 revealed that 18% of total energy intake was provided by three categories of food, cake/cookies/quick bread/pastry/pie, soft drinks/soda, and candy/sugars/sugary foods. These foods represented 41% of total sugar and 61% of added sugar in the diet (Keast *et al.*, 2013). If the fundamental cause of obesity is positive energy balance, then correction by eating less and exercising more is logical but difficult to implement long term resulting in a high rate of recurrence. The adage that 'the best treatment is prevention' could have been created to describe obesity.

Unfortunately, difficulty losing excess fat results in obesity developing and persisting for a long period of time if not always, allowing time for adipocytes and other substances to cause damage. Adipocytes are metabolically active endocrine glands, which have wide-ranging effects on metabolism, such as appetite regulation, secretion of acute phase reactants and proinflammatory factors, and other metabolic functions (Achike *et al.*, 2001; Halberg *et al.*, 2008). Hormones and cytokines produced by the adipocytes termed adipokines that are associated with insulin resistance include adiponectin, leptin (excess), plasminogen activator inhibitor-1, resistin, retinol

Table 15.1. Prevalence (%) of body mass index in children and adolescents by sex and age for 1976-2012 NHANES; Obese = BMI for age ≥95th percentile of the CDC Growth Charts; overweight or obese BMI for Age ≥85th percentile of the CDC Growth Charts (Fryar *et al.*, 2012; Hedley *et al.*, 2004; Kubena, 2015; Ogden *et al.*, 2002, 2006, 2010, 2014; Troiano *et al.*, 1995).[1]

NHANES	Boys 6-11 years		Girls 6-11 years		Boys 12-19 years		Girls 12-19 years	
	>85th	>95th	>85th	>95th	>85th	>95th	>85th	>95th
1976-1980[2]	–	6.7	–	6.4	–	4.8	–	5.3
1988-1994[2]	–	11.3	–	10.0	–	11.4	–	9.9
1999-2000	31.9	15.7	27.4	14.3	30.0	14.8	30.0	14.8
2003-2004	36.5	19.9	38.0	17.6	36.8	18.3	31.7	16.4
2007-2008	35.9	21.2	35.2	18.0	35.0	19.3	33.3	16.8
2011-2012	33.2	16.4	35.2	19.1	35.1	20.3	33.8	20.7

[1] Data from NHANES, surveys designed to assess the health and nutritional status of adults and children in the USA since the 1960s (www.cdc.gov/nchs/nhanes/about_nhanes.htm).

[2] Adolescents 12-17 years of age. Data on those with BMI's ≥85th percentile of the CDC Growth Charts were not available.

binding protein-4, TNF-α, and visfatin (Ouchi *et al.*, 2011; Van Gaal *et al.*, 2006). Accumulation of adipocytes occurs in sites other than normal adipose depots. These abnormal sites, including the VAT, heart, and vasculature, are called ectopic fat, a source of great concern because of potential cardiometabolic connections (Britton and Fox, 2011). One theory of development of ectopic fat involves a continuing positive energy balance resulting in storage of excess fatty acids in SAT (nonectopic fat) to its capacity. Future storage then occurs in the VAT, liver (non-alcoholic fatty liver disease), perivascular fat, and other non-adipocyte-storage tissues (all ectopic fat). A question about the validity of waist circumference in assessment of cardiometabolic risk from obesity relates to the presence of both SAT (non-ectopic fat) and VAT (ectopic fat) in this measurement (Britton and Fox, 2011). In obesity, VAT has been reported to become infiltrated with macrophages after which production of adipokines increases (Ouchi *et al.*, 2011). Adiponectin is an adipokine that has anti-inflammatory and pro-insulin sensitivity effects although its secretion is inhibited in obesity. This is in contrast to other pro-inflammatory and anti-insulin-sensitivity adipokines, including resistin and visfatin, the effect of which increases proportionately with increased fat mass. Obesity is being viewed by some as an imbalance of pro- and anti-inflammatory adipokines that is responsible for the obesity-related complications, including insulin resistance and CVD (Ouchi *et al.*, 2011). In obesity, free fatty acids in the blood increase because of lipolysis from the larger fat mass. Subsequent insulin resistance and beta-cell destruction led to use of the term lipotoxicity, another method by which damage occurs in obese individuals (Poitout and Robertson, 2008).

Obese children and adolescents in a state of continual energy excess accumulate adipose tissue predominantly in the relatively metabolically-inactive SAT. However, at some point ectopic fat stores can appear and foster development of the metabolic and cardiovascular complications of obesity. These include increasing glucose intolerance with eventual T2DM, blood pressure with eventual HTN, blood lipids with eventual dyslipidemia, and risk of eventual CHD.

15.2.1 Diabetes

T2DM, which was called adult onset diabetes in the past, is being diagnosed increasingly in children and adolescents. Dabelea reported that youth accounted for 20 to 50% of new cases of T2DM, disproportionately affecting minority race/ethnic groups (Dabelea *et al.*, 2014). Since obesity is considered to be a major cause of T2DM, associating increased obesity in children and adolescents with increased T2DM is an easy connection to make. Analysis of diagnosis of T2DM in youth ages 10-19 years between 2001 and 2009 in centers in California, Colorado, South Carolina, Ohio, and Washington state indicated that prevalence increased in both sexes, all age-groups, and in white, Hispanic, and black youth. No significant differences were observed for Pacific Islanders and American Indians. Overall, the increase was 30.5% (Dabelea *et al.*, 2014). An earlier study of adolescents aged 12-19 years in the Continuous NHANES 1999-2010 examined prevalence of undiagnosed and diagnosed T2DM on the basis of interview (n=11,888) and fasting blood glucose (random sample n=4,661) (Demmer *et al.*, 2013). Authors concluded that of all adolescents with diabetes in the USA, T2DM occurs in approximately half, of which one-third is undiagnosed. The latter is of particular concern because of cellular changes that take place with intracellular hyperglycemia.

Diabetes occurs because of the lack of supply of insulin and/or lack of effective insulin, leading to hyperglycemia. Elevated glucose levels and fluctuations in glucose levels from high to low in non-insulin-dependent cells, such as neurons in the nervous system, endothelial cells in the vascular system, and pancreatic beta cells, cannot be controlled by the respective cells. In diabetes, the result is generation of high reactive oxygen species and oxidative stress, which in turn leads to glycation of proteins and the formation of advanced glycated end products. Complications of diabetes, including microvascular (neuropathy, retinopathy, and nephropathy), and macrovascular diseases (CVD and HTN), are considered to occur because of the presence of oxidative stress and advanced glycated end products (Giacco and Brownlee, 2010; Negre-Salvayre *et al.*, 2009). Glycemic control has been confirmed to reduce the incidence of microvascular complications, while prevention of T2DM is needed to avoid macrovascular ones (Anonymous, 1998; Gubitosi-Klug, 2014). Loss of fat mass/weight loss has been found to be beneficial in obese children to reduce hyperglycemia and thus risk of developing T2DM.

15.2.2 Hypertension

Studies of blood pressure in children and adolescence indicate that increased primary HTN is attributable to the increase in prevalence of obesity in this population along with salt intake and abdominal obesity (Falkner, 2015; Rosner *et al.*, 2013). HTN is a risk factor for the development of CVD and, in adults, is related to vascular damage and thus target organ damage in tissues, particularly kidney (chronic kidney disease) and brain (CVA). While pediatric HTN had been linked primarily to increasing risk of HTN in adulthood, target organ damage is being reported in children and adolescents in cardiac tissues and other tissues as well (Falkner *et al.*, 2013; Mitchell *et al.*, 2007). Non-obese adults with a history of obesity in childhood were reported to have levels of risk for T2DM, HTN, and other cardiovascular outcomes similar to those who had not been obese earlier in life (Juonala *et al.*, 2011). This provides impetus for achieving weight loss by children and adolescents.

15.2.3 Dyslipidemia

Cardiovascular risk factors include abnormal lipoprotein levels, in particular high LDL-C and low HDL-C. Data from NHANES 1999-2008 revealed that, during this period, high levels of LDL-C and low HDL-C became less common among USA adolescents than in the past (May *et al.*, 2012). Similar findings were reported by Kit (2015) from a more recent data set, NHANES 1999-2012 although 20% of the 8-17-year-old population continued to have adverse concentrations of TC, HDL-C, or non-HDL-C. When data on cardiovascular risk factors of prediabetes/diabetes and prehypertension/hypertension were included, a total of 49% overweight and 61% obese adolescents exhibited at least one of these risk factors. Despite ongoing conversations about the relationship between specific lipoprotein fractions and development of CVD, the proportion of youth at risk for CVD is untenable (Flock *et al.*, 2014; Siri-Tarino *et al.*, 2010). Another concern related to childhood obesity involves its independent effect on carotid IMT in adults (Freedman *et al.*, 2008). Adult IMT is related to subsequent myocardial infarction and CVA. Obesity is a consistent factor in the development of T2DM, HTN, and dyslipidemia for children and adolescents, and must be addressed effectively. Dietary intake of children and adolescents should promote optimal weight with foods chosen to ensure adequate nutrients for growth and development and to promote cardiometabolic health.

15.3 Cholesterol-containing foods for children and adolescents

Foods containing cholesterol come only from animals and fish in which cholesterol is needed to sustain life. Mammalian tissues require cholesterol for plasma membranes, steroid hormones, and other functions. Biosynthesis can provide all of the cholesterol needed by the body, although some routinely comes from exogenous sources. Plants contain plant sterols and stanols, a requisite for plant structure, but these substances are not absorbed in the mammalian intestine (Cofan and Ros, 2015).

In the 1960's recommendations about foods to avoid in order to prevent CVD were developed using the concept that dietary cholesterol directly affected serum cholesterol levels (TC), a strong risk factor for CVD (McNamara, 2000). Consequently, limitations on consumption of cholesterol-containing foods (animal-source foods) were recommended, including the specific restriction of 2 eggs/week (<300 mg cholesterol/d) from the American Heart Association (Lichtenstein *et al.*, 2006). Data used as the basis for these recommendations have been reexamined and now are considered to have been misinterpreted (Fernandez, 2010; Fernandez and Calle, 2010). Conclusions from recent epidemiologic studies indicate no link between dietary cholesterol and coronary disease or death. Individuals sensitive to dietary cholesterol (25% population) respond with increased LDL-C and HDL-C but the ratio of LDL-C/HDL-C, considered to be helpful in determining risk of CVD, is maintained (Fernandez, 2012). This was noted in a systematic review of research on the relationship between dietary cholesterol and serum cholesterol and CHD (Berger *et al.*, 2015). Intakes of 500-900 mg/d dietary cholesterol (but not higher) increased levels of TC, LDL-C, and HDL-C. This review failed to identify studies proving a relationship between lower intakes of cholesterol with lower risk of CHD (Berger *et al.*, 2015). Progress in recognition of the fact that dietary cholesterol is likely not a factor in development of CVD is indicated by the point that, while cholesterol was included as a dietary component to decrease in the Dietary Guidelines for Americans, 2010 (http://tinyurl.com/ookd2e8), cholesterol *per se* is not included in that category in the 2015 Scientific Report (Dietary Guidelines Advisory Committee, 2015). Recommendations for inclusion of all meat, poultry, and eggs, however, is about 93.3 g eq/day for children 4-8 years, about 124.4 g eq/day for boys 9-13 years and girls 9-18 years, and 140.0 g eq/day for boys 14-18 years (Dietary Guidelines Advisory Committee, 2015). Examples of 31.1 g eq is one egg and 31.1 g of beef or chicken. Therefore, concern exists about this continued restriction on cholesterol-containing foods, which are nutrient-dense, and if low-fat, also low energy.

Meat, milk and eggs have a long history of consumption, but were not always in sufficient amounts for adequate consumption. In some countries, there existed no cattle and in others insufficient land to raise cattle (Wiley, 2011). In the United States, the farmers who produced meat and milk often had sufficient amounts; but as urban areas grew in size, the percentage of the population with access to both these commodities declined. Disease and low productivity kept the egg supply low for centuries. In the United States, only after a series of changes in production practices and transportation starting in the mid-nineteenth century did this begin to change.

15.4 Milk – a complex, if not quite perfect food

15.4.1 History of milk consumption in the United States

Some have claimed that milk played a significant role in human survival (Valenze, 2011). However, many cultures had no access to cattle until very recent times; those that did converted it to something with longer shelf life than milk (e.g. yogurt, cheese). Until the mid-nineteenth century, most Americans drank little fresh milk (DuPuis, 2002). Cattle had been brought from Europe in the 1600s, but it took until the late 1800s for farmers to develop animals that could produce milk (http://tinyurl.com/ookd2e8). Difficulties in transporting milk, while keeping it safe, and lingering problems with sanitation issues led to low levels of consumption until the early 20th century. It took new standards for the production of clean milk on farms and convincing the public that pasteurization was safe before consumption began to climb. Physicians, milk companies and the USDA Dairy Division played key roles in the efforts to increase milk consumption.

Technical issues involving milk preservation from bacteria depended on technological change to be resolved. Unlike beef, transporting milk by railroad over long distances was never as significant. In the 19th century, most cities and towns continued to rely on local farms for their milk. Not enough dairies existed near these locales to provide milk for all; further, much of it was unsafe to drink. In some places local train service performed milk delivery. Even with this system, milk kept less readily because ice served as the refrigerant. Despite this drawback, (Craig *et al.*, 2004) refrigeration of milk and other dairy products played a role in increased consumption. Mechanically refrigerated cars, introduced in 1925, allowed greater spread on milk and ice cream over longer distances.

Growing demand for milk in the first half of the 20th century was met by growing production, thanks in part to the introduction of new technologies such as milking machines and more modern milking parlors. In the USA the earliest consumption rates indicate that in 1909, per capita sales of whole milk average 55.7 kg per year (http://tinyurl.com/nprgz9j). Sales rose with some fluctuations until 1944 when they peaked at 118.9 kg per year. Speculation (Pillsbury, 1998) regarding the steady decline in milk consumption involves the appearance of a growing number of competitive beverages and the cost of milk.

15.4.2 Milk consumption by children and adolescents

Consumption of milk has continued to decline in the USA, particularly among children and adolescents. 2 to 11 year-olds consumed about 3.1 dl of milk daily, representing a decline of 1.2 dl since 1977-1978. The decline among adolescents was greater, falling from 4.1 dl in 1977-1978 to less than 2.4 dl in 2005-2006 (Sebastian *et al.*, 2010). NHANES data found that children 2-11 averaged 367.0 ml of whole milk while adolescents averaged 258.2 ml in 2005-2006. This same report finds that regardless of the children's or adolescents' ages, girls always consumed less milk than boys. Hispanic children, regardless of age, consistently drank less milk than Blacks or Whites. An earlier study of NHANES 1999-2000 data reported for female and male African American children drank less milk than other non-Hispanic Whites or Asian/Pacific Islanders (Fulgoni *et al.*, 2007). As they grew older, African-American's intake increased, but never reached the intake levels of non-Hispanic Whites. Adolescents whose families were 101-185% above the poverty line drank less milk that those whose families were >350% above the poverty line. It was estimated that between 10 and 20% of children's and adolescents' daily intake of cholesterol came from milk. The consequences of the decline in milk consumption are significant including attempts to link the increase in obesity with the substitution of sugar-sweetened beverages for milk (Dietz, 2006).

Popkin (2010) traced beverage consumption patterns in children and adults from 1977-1978 to 2005-2006, finding that children 2-18 increased their intake of low-fat milk from 7.3 kcal to 27.8 kcal. Over this time period, these children decreased their energy intake from whole milk from 241.8 kcal to 130.0 kcal. However, younger children's intake of low fat milk grew from 63 ml among 2-6 year olds to 68 ml for 13-18 year olds; whole milk intake was 268 ml for the youngest children but only 106 ml for the oldest group of children. Adolescents in Australia decreased their intake of milk as they aged from 14 to 17 years old; most of the decline was from whole milk (Parker *et al.*, 2012). Males slightly increased their intake of flavored milks. Cheese intake also increased among boys and girls (Parker *et al.*, 2012). Feferbaum *et al.* (2012) performed a study of children/adolescent fluid intake in five Brazilian cities over a 4-day period, finding that older children drank more soft drinks than younger; 25% of 3-year olds obtained 25.3% of their energy from fluids via milk and dairy; older children consumed progressively less; those between 11 and 17 years of age obtained 6.7% of their energy source from milk.

However, Poti *et al.* (2013) found that increased solid fats in children's diets was due to flavored milk and French fries served in schools and the amount of cheese found in store bought pizzas.

15.4.3 Milk's role in nutrition and health of children and adolescents

Because of the wide range of nutrients and bioactive peptides included in milk, it has been called the most complex food (Pasin and Comerford, 2015). Contribution of milk to nutritional adequacy in children and adolescence is substantial, starting with high quality protein. Keast *et al.* (2013) determined energy and nutrients contributed by foods and food groups in the diets of children 2-18 years old from NHANES 2003-2006. Results for milk with and without cheese intake are shown in Table 15.2. Cholesterol, the component responsible for restriction of the food for decades, is shown as well. The quantity and variety of nutrients provided in comparison to percentage of energy intake is remarkable. Slining *et al.* (2013) reported sources of energy in diets of children ages 2-18 years assessed with data from NHANES 2009-2010. Data indicate that energy provided by milk in this time period was 9.2%, an increase from the 7.0% reported for NHANES 2003-2006 (Keast *et al.*, 2013). Consequently, milk could be making an even greater impact on dietary adequacy of children and adolescents than what is shown in Table 15.2.

Milk and dairy products also are considered to be an excellent source of bioactive peptides that function in appetite suppression (the whey protein glycomacropeptide or L-leucine), enhanced satiety (digestive product of casein), and other health outcomes (Ricci-Cabello *et al.*, 2012). However, even before isolated bioactive peptides are available, drinking milk works.

Investigations into the effect of milk and dairy products on energy balance and body weight in children and adolescents yielded results that were sometimes positive and sometimes not (Abreu *et al.*, 2012; Louie *et al.*, 2011; Wiley, 2010). A systematic review of pre-school children through adolescence indicated that milk intake was not related to body weight in pre-school and schoolaged children while dairy intake in adolescents was inversely associated with adiposity (Dror, 2014). As discussed by the author, mechanisms by which the modest effect on fat mass in adolescents occurs have not been identified. Further investigations of calcium's effect on intestinal fat absorption, the mineral's antilipogenic effect at the cellular level, conjugated linoleic acid, and the milk fat globule membrane may identify mechanisms that explain the effect (Dror, 2014). Regardless of etiology, the effect of milk intake that decreases adiposity in adolescents is important in light of the prevalence of obesity in youth in this country.

Table 15.2. Milk and cheese as sources of energy and nutrients in diets of US children aged 2-18 years (NHANES 2003-2006) (adapted from Keast *et al.*, 2013).[1]

Energy/nutrient	% total[2]	Energy/nutrient	% total
Energy	7.0 (11.7)	Vitamin B6	6.1 (6.1)
Protein	13.2 (22.9)	Folate	3.7 (3.7)
Vitamin D	60.4 (62.7)	Vitamin B12	24.7 (31.1)
Calcium	33.2 (52.6)	Phosphorus	21.3 (33.1)
Potassium	18.8 (20.8)	Magnesium	13.3 (16.8)
Vitamin A	23.3 (32.7)	Zinc	10.8 (18.8)
Thiamin	7.0 (7.0)	Cholesterol	9.7 (19.3)
Riboflavin	23.9 (29.2)		

[1] Foods providing >1% of total intake of energy or that nutrient.

[2] Figures in parentheses include intake of cheese.

An area of particular interest with milk is its role in the prevention of inflammation, a factor considered to be involved in elevated blood pressure, glucose intolerance/T2DM, and CVD risk. While mechanisms are unknown at this time, multiple reports exist of intake of dairy products suppressing numerous inflammatory markers, including TNF-α, interleukin-6, and downregulating genes encoding for proinflammatory cytokines (Da Silva *et al.*, 2005). Potential mediators could be fatty acids, including naturally-occurring trans-fatty acids, milk proteins, and minerals (Kim *et al.*, 2013; McGregor and Poppitt, 2013; Siriwardhana *et al.*, 2013).

Numerous research reports that evaluated relationships between components of milk and development/prevention of CVD have been published in recent years (Huth and Park, 2012; Rice *et al.*, 2011). The current perspective on milk and dairy products is that the plethora of bioactive components of this food group includes substances that have the capability of reducing and preventing the inflammatory process as previously discussed, promoting insulin sensitivity and insulinogenesis, enhancing endothelial function and lowering blood pressure, preventing hypercoagulability, and positively affecting other measures of cardiovascular health.

Evolving understanding of the relationship between fatty acids and health, however, has resulted in recommendations for caution with respect to encouraging intake of full-fat dairy products. The active components identified in the analyses of beneficial health outcomes from milk include conjugated linoleic acid, monounsaturated fatty acids, trans-fatty acids (trans-palmitoleic), vitamin D, vitamin A, calcium, magnesium, potassium, whey proteins, and others along with combinations of these (Dakshinamurti, 2015; Huth and Park, 2012; Rice *et al.*, 2011). Current thoughts are that dairy products are beneficial for decreasing risk of CVD and T2DM. In response to research in the area, Beydoun *et al.* (2008) questioned whether differences in intake of dairy products by ethnic groups could explain part of the variation in cardiometabolic risk factors and disease among these groups.

In the treatment of T2DM, HTN, and dyslipidemia, an important goal is optimal body weight (Eckel *et al.*, 2014; Evert *et al.*, 2014). Nutrient adequacy is essential to prevent problems of deficiency of individual nutrients to avoid development of other diseases. The fact that nutrients and other bioactive components of milk have been identified that are associated with prevention of the conditions related to CVD and also may decrease adiposity in adolescents makes this food one that should be recommended strongly for all children and adolescents.

15.5 Eggs – good things come in small packages

15.5.1 History of egg consumption

Humans have eaten eggs from various species of fowl for several millennia. In present times, most of the eggs eaten across the globe come from chickens. In the United States, egg production took place on small farms or in backyards of urban housing into the first several decades of the 20th century. Various factors, such as parasites and disease, kept production low. Sanitation of living conditions contributed to the spread of disease, which was eventually dealt with by placing hens in housing with wire-flooring. Seasonality was another limit placed on hen productivity; chickens are sensitive to the length of the day and fewer hours of daylight reduced egg production (Freidberg, 2009). This was overcome to a degree by placing lights in chicken houses. As hen health and egg production increased, small farms were replaced by large companies that produce millions of eggs per day (http://www.uspoultry.org/about/history.cfm).

From 1909 until 1945, egg consumption increased, reaching 404 eggs per capita per year. After this time, egg consumption began to decline apparently as consumers began to worry about cholesterol in their foods (McIntosh, 2000). The decline ceased in the early 1990s and began to increase. More recently, it has leveled off at 245.8 eggs per person per year (USDA, 2014)

15.5.2 Egg consumption by children and adolescents

Cereals and breads are consumed more frequently at breakfast in the United States, but 14% of those who eat this meal at home include eggs; 17% of those who eat away from home do so (USDA ARS, 2012). The average intake at a meal is two eggs. 13% of children aged 2-11 and 15% aged 12-19 consume eggs for breakfast, respectively. Recent data on children's egg intake by gender are not available; however, using the 1994-1996 USDA Continuing Survey of Food Intakes by Individuals (Smicklas-Wright *et al.*, 2002) reported that 87.3% males and females aged 2-11 ate at least one serving of eggs; 48.4% consumed eggs on 2 days. These percentages were much the same for children aged 6-11 and for those aged 12-19. In general the differences in female versus male intakes within these age groups differed by less than 3%.

15.5.3 Eggs' role in nutrition and health of children and adolescents

One of the most nutritious foods available, the egg was considered a significant threat for development of CVD for decades. Now that concern about direct association between cholesterol in foods (186 mg/large egg) (USDA, 2013) with CVD has decreased, reduction in cholesterol intake is not mentioned specifically in the Scientific Report for the 2015 DGA except for the previously-mentioned maximum of 93.3-140.0 g eq/day for children 9-18 (Dietary Guidelines Advisory Committee, 2015). Concern remains about egg consumption and increased cardiometabolic risk in certain individuals.

The Harvard egg study included 38,000 men and 80,000 women from two prospective studies of health professionals to identify the association between egg consumption (<1/week to >1/week) and cardiac events (Hu *et al.*, 1999). Risk was not increased in this population although unease existed about diabetic subjects. That same concern continues today as studies illustrate no effect or a positive one on CVD risk with eggs except for diabetic subjects or those at risk of diabetes. Recent meta analyses on egg consumption, CVD risk, and diabetes indicated that egg consumption in non-diabetics is not related to increased CVD risk (and may decrease risk), but it is associated with increased risk of CVD in diabetics (Li *et al.*, 2013; Rong *et al.*, 2013; Shin *et al.*, 2013; Tran *et al.*, 2014). Egg consumption leads to increased LDL-C in most people but larger less-atherogenic molecules of LDL-C also increase along with increased HDL-C. Of importance is the fact that the LDL-C:HDL-C remains the same (Blesso *et al.*, 2013; Herron *et al.*, 2004). A recent study of diabetics on a restricted carbohydrate diet indicated that eggs increased insulin sensitivity as compared to egg substitutes (Blesso *et al.*, 2013) so even diabetics seem to benefit from eggs under the right conditions, e.g. low carbohydrate diet.

Evaluation of quality of protein involves comparison of the amino acid profile with needs of amino acids by age group (protein-digestibility-corrected amino acid score) with 100% being perfect. The score of egg protein for children is 118% (Iannotti *et al.*, 2014). In comparison to other food proteins, egg is also the most affordable protein (Drewnowski, 2011).

The percentages of nutrients provided do not seem that high until one considers the fact that presence of eggs in the diet represents <1% energy. If recommendations were to increase intake of these nutritious poultry products, the nutrient contribution to the diet would increase quickly. Eggs also are excellent sources of choline and the carotenoids lutein and zeaxanthin and provide vitamin A, vitamin D, folate and iron (all shortfall nutrients), plus DHA and selenium. Lutein and zeaxanthin (252 μg/egg) (Goodrow *et al.*, 2006) are involved in formation of HDL-C, which transports these same carotenoids to the eye where they are involved in formation of the macular pigment. That pigment protects the eye from oxidative damage and thus cataract and macular degeneration (Hobbs and Bernstein, 2014).

Weight reduction efforts that include lower food intake result in hunger and increased appetite. Comparing a cereal breakfast to one with eggs, subjects reported more feelings of fullness with eggs (Bayham *et al.*, 2014). Previous studies had indicated that lunch intake was less after an egg breakfast as compared to cereal (Vander Wal *et al.*, 2005). Components of egg that likely are involved in reduced appetite are its content of very high quality protein and L-leucine, the latter known to be instrumental in appetite control (Iannotti *et al.*, 2014). However, a 2015 study indicated that an egg breakfast was not associated with a lower intake later in the day by adolescents even though ghrelin was suppressed (Lin *et al.*, 2015).

Table 15.3. Eggs as a source of energy and nutrients in diets of US children aged 2-18 years (NHANES 2003-2006) (adapted from Keast *et al.*, 2013)[1]

Energy/nutrient	% total	Nutrient	% total
Energy	–[2]	Vitamin E	2.2
Protein	2.3	Riboflavin	2.7
Vitamin D	2.7	Vitamin B12	2.7
Vitamin A	3.1	Cholesterol	24.2

[1] Food providing >1% of total except eggs.

[2] Food provided <1% of total energy.

If the high-protein egg perhaps is helpful in compliance with calorie reduction to achieve and maintain normal body weight, then this is one more reason to encourage children and adolescents to consume eggs, those tiny inexpensive packages filled with high-quality nutrition and antioxidants that can make a great difference in vision as one ages but probably earlier, too. Concerns about its threat to CVD risk seemed to have been an overreaction although some caution remains especially for diabetics.

15.6 Meat – a juicy issue

15.6.1 History of meat consumption

Beef was very much a luxury item until nearly the end of the 19th century when new technology made beef more available and easier to cook. In the USA, people ate more pork than beef from colonial days until the end of the 19th century. Cattle slaughter began to concentrate in large cities and their carcasses were transported to other towns and cities made possible by the spread of a railway system that had begun to connect these places with the sources of beef (Cronon, 1991). Soon after this the refrigerator car was invented, allowing beef to be shipped longer distances (Horowitz, 2006). By the end of the 1940s, most dwellings had a refrigerator allowing meat to remain fresh for a longer period of time at the household level.

Chicken was brought to the Americas by early explorers of this continent. Chickens were apparently easy to raise, and many rural as well as urban dwellers maintained flocks. According to Horowitz (2006), by 1910, nearly 90% of USA farmers raised chickens with averaged sized flocks of 80. Despite its widespread availability, consumption of both chickens and fish remained low from 1909 till the mid-1940s, after which poultry consumption grew steadily reaching about 75 g per person per day (Daniel *et al.*, 2011). Fish consumption, by contrast, has remained relatively flat over this same time period. Chicken consumption remained low in earlier times in part because the quality of the animals varied greatly as did the price. For the first half of the 20th century, the cost of chicken remained higher than that of beef and pork. By the 1950s, quality issues had been resolved but the economics now required the raising of 'building better chicken houses, buying more expensive chicks, and providing improved feeds all required capital that farmers did not have' (Horowitz, 2006). Large food companies took over the production of chickens. Reduction in price and an increase in the perception of the healthiness of poultry compared to red meat have meant continued grow in its consumption.

In the early years of American history, fish played great roles as a means of survival for the early colonists and later as an export commodity (Jarvis, 1988). As a part of the American diet, fish was largely confined to communities near coastal areas of North America. Much of this fish was dried and salted, given the propensity for fish to spoil. The invention of refrigeration provided longer shelf life, but it was not until the advent of flash freezing in the mid-20th century that provided a means of maintaining fish's taste and quality (Freidberg, 2009).

Total meat consumption in the USA grew from nearly 250 g per capita per day in 1961 to over 300 g per capita per day in 2003 (Daniel *et al.*, 2011). From 1909 total meat consumption increased from a little over 150 g per person per day to nearly 250 g per person per day. Much of the early levels of meat consumed consisted of red meat, which increased in step with total meat intake until 1975. After this while meat consumption continued to climb, red meat consumption began to decline, leveling off at about 13 g per day per person. An increase in chicken consumption largely accounts for the increase in total meat consumption. However, this same paper indicates that percent intake of meat consisted of 58% red meat, 32% poultry, and 10% fish in 2003.

15.6.2 Meat consumption among children and adolescents

One study found that adolescents ate less beef and pork during the period 1977-1978 to 1994-1996 (Enns *et al.*, 2003). In a study of children in Australia, Clayton *et al.* (2009) found that in 1985 that male children aged 10-11 years of age, on average, consumed 60.1 g from beef, 17.1 g of lamb, and 11.7 g pork daily. Females consumed slightly less. Older children consumed more beef, lamb and pork. By 2003, the amount of beef children consumed declined, with the greatest decline observed for females aged 12-15. However, in this age group both females and males increased their intake of both lamb and pork by 2003. Fish intake increased as well. Another Australian study focused on the meat consumption of children aged 2 years or younger found that as children became older, their intake of unprocessed beef, lamb, and pork increased yet remained below guidelines for a healthy diet (Mauch *et al.*, 2015).

According to NHANES, 2003-2004 data, children aged 2-11 consumed an average of 30.6 g/day of poultry and 5.9 gm/day of fish, while children aged 12-19 consumed an average of 46.2 g/day of poultry and 7.6 g/day (Daniel *et al.*, 2011). More recent data from NHANES indicates that 2-11 year olds averaged 28.5 g/day of poultry and 3.8 g/day of fish; among 12-19 olds, these increased to 55.6 g/day and 6.5 g/day, respectively (Rhodes *et al.*, 2012). Parents were found to eat more frequently in a study of New York City families. Nearly 60% of parents indicated they ate fish at least once a week while only 53% of their children did so. Nearly a quarter of both parents and children consumed fish twice a week and between 10% and 7% of parents, respectively, ate fish 3 to 4 times a week. Fish preferences of parents overlapped considerably: the both parents and children indicated they preferred shrimp, salmon, crab, and lobster. They differed over scallops (which parents preferred) versus fish sticks (which children preferred) (Herdt-Losavio *et al.*, 2014).

15.6.3 Meat's role in nutrition and health of children and adolescents

Meat is considered to be a high nutrient food that provides high quality protein and important micronutrients, including many of the nutrients considered to be shortfall nutrients recommended to be increased in the diet. The 2010 DGA indicated meat and poultry are routinely included in the diet although lean forms should be used to decrease intake of solid fat (USDA ARS, 2010). The 2015 Scientific Report of the 2015 DGA Advisory Committee (Dietary Guidelines Advisory Committee, 2015) state that a healthy diet is 'lower in red and processed meat', and a footnote indicates that lean meats can be included in a healthy dietary pattern. The change from assuming that lean meats are in the diet (2010) to they may be in a healthy diet (2015) seems to say that lean red meat is being encouraged less for inclusion of a healthy diet than it has been in the past. Increased intake of fish and shellfish was encouraged.

Contribution of nutrients by beef, pork, poultry, and fish in diets of children and adolescents in the USA was assessed from NHANES 2003-2006 (Keast *et al.*, 2013) and is shown in Table 15.4.

Despite surprisingly low intakes, significant amounts of nutrients came from meat. Beef and pork represented about 4% energy each, while youth consumed less than 1% energy as pork and <1% energy as fish and shellfish. High quality protein, nutrients needed to be increased in the diet, iron, potassium, vitamin E, and magnesium, and zinc and vitamin B_{12}, were provided by beef, pork, and poultry. Fish and shellfish are excellent sources of nutrients beyond protein, vitamin B_{12}, and vitamin D, but not illustrated in Table 15.4 because of the tiny amount of fish consumed. These include potassium, selenium, fluorine, iodine, thiamin, riboflavin, niacin, vitamin B_6, and most importantly DHA and EPA, that content varying with the fat content of the species (Oehlenschlager, 2012). Methyl mercury contamination of waters is a concern perhaps affecting fish consumption. A study by Nielsen *et al.* (2015) indicated that >60% of children aged 2-19

Table 15.4. Beef, pork, poultry, and fish/shellfish as sources of energy and nutrients in diets of US children aged 2-18 years (NHANES 2003-2006) (adapted from Keast *et al.*, 2013).[1]

Energy/nutrient	Beef (% total)	Pork, ham, bacon (% total)	Poultry (% total)	Fish, shellfish (% total)
Energy	3.8	–[2]	4.4	–[2]
Protein	11.5	4.2	12.8	2.1
Potassium	4.4	2.0	4.1	–
Vitamin E	2.1	–	4.3	–
Riboflavin	2.6	–	3.0	–
Niacin	7.5	3.2	13.8	–
Thiamin	–	5.5	–	–
Vitamin B6	6.8	2.8	7.6	–
Vitamin B12	14.7	–	2.2	5.2
Phosphorus	5.0	2.6	6.6	–
Magnesium	2.9	–	4.1	–
Iron	5.1	–	2.7	–
Zinc	16.6	2.7	5.4	–
Vitamin D	–	–	–	3.5
Cholesterol	11.5	3.8	13.2	2.1

[1] Foods providing >1% of total except pork.

[2] Food provided <1% of total.

years in the USA consumed fish or shellfish within the last 30 days although <0.5% had a blood mercury level above the EPA Reference Level of 0.58 μg/l.

Bioactive peptides have been identified in all four types of meats. Most of them function as antihypertensives, especially in ACE inhibition, while some have antithrombotic and/or antioxidative properties as well (Huang *et al.*, 2013).

Consumption of fresh and processed pork represented less than 1% of energy, and information on proportion of fresh pork as compared to processed ham and bacon (food group = pork, ham, and bacon) was not available. The processed meat group of frankfurters, sausages, and luncheon meat provided 3.2% of energy with nutrients representing the protein source and other ingredients used in their production (Keast *et al.*, 2013). Processed meat has been implicated in development of chronic disease so that intake is discouraged. On the other hand, beef, pork, poultry, and fish and seafood are high-nutrient-density low-energy-density (if low fat) foods that can be recommended.

This conclusion was reinforced by recent dietary intervention studies of red meat (Roussell *et al.*, 2011, 2012). A 2011 study demonstrated improved blood pressure with inclusion of 141 g red meat/day as compared to 28 g/day while the 2012 RCT using the same levels of beef reported lipoprotein reduction that was equally effective with the higher or lower beef intake. In fact apolipoprotein B reduction was enhanced by more beef. Bradlee *et al.* (2014) reported that inclusion of lean beef in the diet of adolescent girls was associated with a slight reduction in LDL-C, more evidence of safety of lean beef but this time with youth. Beef as a component of weight loss programs has been reported to be as effective as other types of animal or plant protein as a part of higher protein diets (McNeill and Van Elswyk, 2012).

A systematic review of the relationship between intake of red and processed meat and risk of CHD, T2DM, and CVA was reported by Micha (2010). Red meat was not associated with presence of these cardiometabolic problems while intake of processed meat resulted in an increased risk of 42% CHD and 19% T2DM per serving. Causes of the differences in risk between processed and red meat could involve the high sodium or nitrate content of the former (Micha, 2010). Results of this study suggest that processed meat, such as frankfurters and other sausages, would not be good choices for children. On the other hand, red meat was not shown to be of concern. Maki *et al.* (2012) in a meta-analysis of randomized controlled trials comparing the effects of beef, poultry, and fish on TC, LDL, HDL, and triacylglycerols in randomized controlled trials conducted between 1950 and 2010, reported no significant differences. Since most studies on red meat have been conducted in North America, two large prospective cohort studies in Shanghai investigated differences in total and cause-specific mortality. Red meat intake (95% pork) as compared to poultry was related to both higher total mortality and risk of ischemic heart disease mortality in men but not women (Takata *et al.*, 2013). Sex differences will be and other variables associated with geographic location should be further investigated.

Few studies of DHA/EPA or fish intake in children exist. Those that do suggest a benefit of these n-3 fatty acids on blood pressure, at least in boys (Bonafini *et al.*, 2015).

Results of research studies on nutrient contribution to diets of children and adolescents in the USA and the relationship between red meat and CVD and T2DM, allow one to conclude that lean meat would be considered a nutrient-dense food that has either a neutral or positive effect on CVD and T2DM. This is not true for processed meat, but fresh red meat seems to be a good choice for children and adolescents in the USA. The conclusion of the 2015 DGA Advisory Committee that a healthy dietary pattern should be lower in processed meat seems wise although the fact that the phraseology is that '... a healthy diet is lower in red and processed meat ...' is curious (Dietary Guidelines Advisory Committee, 2015). Restriction on total amount of meat/poultry/fish/eggs to 93.3-140.0 g eq/day is more than curious.

15.7 Children's food choices – just like dad and mom

While many things affect children's food choices, parents appear to have the greatest influence. To begin with, parents usually develop what is known as a style of parenting. Researchers have identified four types of parenting, each of which tends to produce different behaviors in their children (Macoby and Martin, 1983). Authoritative parenting involves a demonstration of caring for their children, involvement in the children's lives, setting rules for their children and using withdrawal of privileges when these rules are broken. Children raised via this parenting style tend to perform better in school, engage in less deviant behavior and are well-adjusted. In addition, children of authoritative parents tend to eat less fatty foods and eat more dairy products (Vollmer and Mobley, 2013). Indulgent parents who, while caring for their children expect little maturity, tend to have children who exercise control over what they eat, including dairy products. Parents who express less caring and are less involved in their children's lives (referred to as neglectful parenting) have children who consume less dairy. Parents who have created rules about what foods their children should eat less of (e.g. high fat food such as bacon; fried snacks) had children who ate fewer servings of such foods (Durao *et al.*, 2015; Eisenberg *et al.*, 2012) and consumed more milk if their parents pressured them to do so. Other research, however showed that when parents set rules, such as having to clean one's plate or eat more fruits, their children consumed a higher percentage of calories from fat (Birch *et al.*, 2003; Vereecken *et al.*, 2009). Authoritarian parenting involves low levels of caring and high levels of control. In a study performed on 300 families in Houston, results indicated that, when both parents were authoritarian, their children consumed fewer servings of dairy products. Mothers who attempted to control what their children ate and in what amounts tended to have children who ate more meat (McIntosh *et al.*, 2006). While parenting styles are difficult to change, some have found that changing parents' eating habits can lead to similar changes in their children's food choices (Mitchell *et al.*, 2013).

Modeling is a second way that parents can either purposefully or accidentally influence their children's behavior. Some parents who make it a habit to eat healthy foods in front of their children tend to have children that follow suit, particularly in the consumption of fruits and vegetables

(Draxten *et al.*, 2014; Harris and Ramsey, 2015; Skafida, 2013). Several studies have found this also be the case for dairy products (Long-Lambie and Sistani, 2014; Reicks *et al.*, 2011). Others have found that modeling 'inappropriate behavior', such as consuming fats (e.g. butter) or sweets (e.g. candy, cakes) for their children produces similar habits in those children (Wang *et al.*, 2013).

Researchers have found that family rituals, such as dinner tend to lead children to eat more fruits and vegetables and drink fewer sweetened beverages (Skafida, 2013). A USDA-funded study in Houston found that children whose fathers' perceived the dinner as an important family ritual tended to consume more servings of dairy and spent less time in fast food restaurants (McIntosh *et al.*, 2011). Children who reported enjoying eating dinner with their parents consumed more servings of both meats and dairy products (McIntosh *et al.*, 2006).

15.8 Conclusions

Dietary cholesterol, once perceived as a primary factor in CVD because of misinterpretation of research results, is now considered to be fairly innocuous to almost all. Thus, cholesterol-containing foods, milk, eggs, and meat, are resurfacing as highly desirable components of the diet. Analysis of dietary intake of children and youth through NHANES 2003-2006 indicated that 18% of total energy came from baked goods, sweetened soft drinks, and candy/sugary foods (Keast *et al.*, 2013). In the same analysis 16% of total energy was contributed by milk, eggs, and meat (beef, pork, poultry, and fish).

The explosion in obesity and overweight in youth in the United States between 1976 and 2004 resulted in about 18 and 20% of boys and girls, respectively, being categorized as obese with an additional 15% as overweight. Obesity means excess adipocytes, which function as endocrine glands, the source of adipokines, including leptin, TNF-α, etc. Excess adipocytes also are associated with the development of lipotoxicity. Adipokines and lipotoxicity adversely affect insulin sensitivity and appetite control and promote oxidative stress and inflammation. This results in increased risk for T2DM, HTN, CVD, and other problems, now occurring in children and adolescents. Debate is taking place about whether the obesity epidemic in youth in the USA has plateaued or is on temporary hold before increasing again. Dietary change substituting levels of high-nutrient low-energy foods for sugary or fatty ones by children and adolescents in the USA is needed.

Foods coming from animals contain cholesterol, and research seeming to implicate this substance in development of CVD led to severe restrictions on intake of cholesterol and animal protein foods for decades. Updated research and reexamination of original studies resulted in the opportunity to encourage intake of these foods and thus improve nutritional status in children and adolescents. Research indicates that intakes of vitamin A, vitamin D, vitamin E, calcium, magnesium, iron, and potassium are less than they should be, so-called shortfall nutrients (Dietary Guidelines Advisory Committee, 2015). Increased consumption of milk would lead to more vitamin A, vitamin D, calcium, and potassium, nutrients provided in the highest amounts in the diet by milk. Eggs are also a reliable source of vitamin A and vitamin D along with vitamin E. Beef, pork, and poultry provide potassium, vitamin E, magnesium, and iron. Fish and shellfish contain many nutrients, but intake is so low that contributions to the diet are hard to quantify. All of these foods contribute complete animal protein, with egg protein the best protein in the U.S. diet, according to current ranking methods.

Permanent loss of fat mass is extremely difficult so that dietary intake that promotes optimal growth and development, nutrient adequacy, and prevention of obesity in youth is needed. The opportunity to encourage children and adolescents to substitute high-nutrient low-energy animal protein foods for sugar and fat is here. Parents can help motivate their children through appropriate parenting style and role modeling. Caring and supportive encouragement and modeling of enjoyment of appropriate foods will help.

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