Soyfoods for Infants, Children and Adolescents

2011 EDITION

SOY CONNECTION *fact sheet*

Establishing healthful eating habits early in life is important for two reasons. First, childhood eating habits track into adulthood and changing adult dietary behavior is difficult.[1-5] Second, evidence suggests that healthy behaviors during childhood and adolescence can affect the risk of developing certain chronic diseases later in life.[6-9] For example, childhood obesity is associated with an increased mortality from cardiovascular disease in adulthood, independent of adult weight.[10] Early lifestyle factors are also known to affect the likelihood of developing breast cancer during adulthood.[11] These observations are important given that 20 percent of U.S. children are obese[12] and diseases once seen primarily in adults, such as hypertension[13] and Type 2 diabetes mellitus,[14] are increasingly common in childhood.

It is also recognized that the beginning stages of chronic diseases, such as coronary heart disease, are already apparent in adolescents.[15, 16] In addition, there is an emerging epidemic of non-alcoholic fatty liver disease (NAFLD) estimated to affect millions of obese children.[17, 18] A recently published autopsy study found that 9.6 percent of the American population, 2-19 years old, and 38 percent of the obese individuals within this age range have NAFLD[19]. NAFLD can progress to non-alcoholic steatohepatisis (NASH), which is characterized by oxidative stress, inflammation, apopotosis and fibrogenesis.[20] Recent animal data suggest soy may help to prevent the development of NAFLD.[21]

Given the importance of early-life dietary behavior, it is essential to understand how the nutritional attributes of soyfoods may impact the health of young people from infancy through the teenage years.

Soy Infant Formula

Although breast milk is the ideal food for infants,[22] about one-third of women choose not to or cannot breastfeed. Of those who choose breastfeeding, most switch to formula feeding at some point in the infant's first year.[23] Commercially-prepared, fortified infant formulas are appropriate to supplement or replace human milk during the first year of life. Cow's milk formula is the most commonly used product, but about 13 percent of infants are fed soy infant formula (SF) for some period of time.[24]

All soy formulas are fortified with iodine, iron, methionine, carnitine and taurine, and contain 20 percent more calcium and phosphorous than cow's milk formulas.

An allergy to milk protein is among the most common reasons for placing an infant on SF. There is clear evidence that SF is hypoallergenic relative to cow's milk formulas.[25] However, because 10-14 percent of infants who are allergic to cow's milk formula are also allergic to SF, the American Academy of Pediatrics (AAP) suggests that many infants with documented cow's milk protein allergy (CMA) should be switched directly to a hydrolyzed protein

Soyfoods provide high-quality protein and are low in saturated fat.

formula.[26] In contrast, an Australian panel of experts recently concluded that SF is an appropriate alternative for infants over 6 months old who demonstrated immediate food allergy to cow's milk and delayed reaction in the form of atopic eczema and other gastrointestinal syndromes.[27] Furthermore, recent UK research found that, of the 60 percent of all infants with CMA initially treated with SF, only 9 percent remained symptomatic.[28] In contrast, of the 18 percent of patients treated with extensively hydrolyzed formula, 29 percent remained symptomatic. The results from a small retrospective study from Portugal, which evaluated children with persistent CMA, also suggest soy formula may have advantages over hydrolyzed formulas.[29]

Clinical research shows that soy protein directly lowers cholesterol levels in children.

Isoflavones in Diets of Infants Fed Soy Formula

An estimated 20 million people in the United States consumed SF during infancy since it first became commercially available in the 1960s.[24] Several cases of goiter were identified in the mid-1960s in infants using SF but this problem was eliminated soon thereafter with the advent of iodine fortification of the formula.[30-32] Since then, no thyroid problems specifically related to SF use have been identified and research shows that infants fed SF grow and develop normally.[24, 33-36] All SFs are fortified with iodine, iron, methionine, carnitine and taurine, and contain 20 percent more calcium and phosphorous than cow's milk formulas. However, SF may be contraindicated for infants with congenital hypothyroidism who require synthetic thyroid hormone.[37] This is because of evidence suggesting soy protein is one of a number of factors that may interfere with the absorption of thyroid medication.[38]

Despite its long history of use, SF has become controversial in recent years due to the naturally high isoflavone content of the soybean.[39, 40] Isoflavones, often referred to as phytoestrogens, exhibit estrogen-like effects under certain experimental conditions.[41] However, isoflavones are not the same as estrogen. Research in adults shows that many biological measures that are affected by the hormone estrogen are not affected by isoflavones.[42-62] Furthermore, soy protein, which is used in SF, is not the same as isoflavones. Most importantly, there is no clinical evidence in infants that SF consumption leads to adverse effects.[33, 63, 64] Especially noteworthy in this regard are the results from a unique study underway at the Arkansas Children's Nutrition Center, University of Arkansas for Medical Sciences.

In this study, breast buds, uterus, ovaries, prostate and testicular volumes were assessed by ultrasonography in 40 breastfed, 41 milk formula fed and 39 SF fed infants at 4 months of age.[65] In all cases, SF fed infants were similar to breastfed or milk formula fed infants whereas, unexpectedly, milk formula fed infants had greater mean ovarian volume and greater numbers of ovarian cysts per ovary than did breastfed infants. The clinical relevance of these findings is unclear. Additional data from this research group continues to show that for a variety of health outcomes, infants fed SF fall well within the normal ranges.[66]

Long-term data are limited, but in one retrospective study no meaningful differences in a host of biological parameters between adults fed SF or cow's milk formula as infants were noted.[67] Interestingly, results from a very small and very preliminary study found that girls fed SF as infants were 40-60 percent less likely to develop breast cancer as adults compared to women who were fed breast milk, cow's milk formula or a combination of both.[68]

A comprehensive review published in 2004 summarized views on the isoflavone content of SF with this statement: "The evidence from laboratories showing biological activities at doses or tissue concentrations relevant to soy fed infants is difficult to reconcile with the long record of uneventful use of these formulas."[69] This sentiment is similar to the current position of the AAP, which was issued in 2008: "… although studied by numerous investigators in various species, there is no conclusive evidence from animal, adult human, or infant populations that dietary soy isoflavones may adversely affect human development, reproduction, or endocrine function."[26]

Nevertheless, because the types of safety-related research that can be conducted in humans are limited, animal studies are frequently cited in

support of potential adverse effects of SF. Results of these studies may be of questionable value due to the many physiological differences between animals and humans. Furthermore, many animals, including rodents and monkeys, metabolize isoflavones very differently than humans.[70, 71] In 2006, the National Toxicology Program (NTP) Center for the Evaluation of Risks to Human Reproduction evaluated the safety of soy formula. Although their initial conclusions supported the safety of soy formula use, no final report was issued.[72, 73] In 2009, the NTP again took up this issue.

The conclusion of the 14-member panel of independent scientists was that there was "minimal concern" (the five levels of concern are negligible concern, minimal concern, some concern, concern and serious concern) about the safety of SF. Two panel members dissented from this consensus opinion, one in favor of "negligible concern" and the other in support of "some concern." In response to the NTP report, the AAP submitted a formal letter to the NTP, which is part of the public record, in which they stated their position that there is negligible concern about the safety of SF.

Effects of Soy Protein on Cholesterol Levels in Children

As with adults, clinical research in children shows that soy protein directly lowers serum cholesterol levels and improves levels of other lipids.[74-78] In the most recent study, when soy protein (average intake 0.5 g/kg body weight) was incorporated into the diets of children and adolescents (mean age 8.8 years; range 4-18 years) with familial and polygenic hypercholesterolemia, low-density lipoprotein cholesterol decreased by 6.4 percent beyond the 11 percent decrease that occurred in response to the adoption of a standard low-saturated fat diet during the three-month run-in period.[78] Thus, soy protein used in combination with other dietary therapies may reduce cholesterol levels to target goals.[79]

Soy protein may also serve as an adjunct to therapy in children taking medication for lowering cholesterol, thereby reducing the required dose which may help to minimize or eliminate side effects.

Soyfoods are generally well-accepted by children according to studies.

Soy Protein Quality

Soyfoods provide high-quality protein and are generally low in saturated fat.[80] Soy protein can meet the protein needs of growing children. In 2000, the U.S. Department of Agriculture removed limits on the amount of soy protein that can be used in the National School Lunch Program.[81]

Providing healthful sources of protein without excessive saturated fat content is important for children. Higher protein diets are associated with greater satiety and weight loss.[82] Also, recent evidence in young boys shows that consumption of protein above the recommended dietary allowance enhances the favorable impact of physical activity on bone mineral density.[83]

However, many protein-rich foods in children's diets are high in saturated fat. Therefore, substituting soyfoods for more traditional sources of protein generally improves overall diet quality. Even substituting soy protein for part of the beef or pork protein in a recipe can lead to a decrease in the fat, saturated fat and calorie content for the total entree, as long as portion size stays the same.[84, 85] Similarly, combining cheese, eggs or meat with tofu leads to improved nutritional quality of entrees.[86]

In general, soyfoods help children meet the Dietary Guidelines.[84, 86] Short-term studies show that soyfoods support the normal growth and development of children[87] and improve growth when substituted for legumes in the diets of malnourished preschoolers.[88, 89] Thus, soyfoods can play an important part in a healthy and varied diet.

Data suggests that soy intake during adolescence reduces breast cancer risk later in life.

Acceptance of Soyfoods in Children's Diets

Research shows that soyfoods are generally well-accepted by children.[86, 90, 91] For example, among preschool children, 3-6 years old, who attended a Head Start program, children consumed soy-enhanced lunches as readily as those made with more traditional ingredients, as evidenced by the amounts eaten.[90]

Negative beliefs about soy's palatability persist among some populations. When non-vegetarian subjects were told that a product contained soy, they were more likely to rate it as "grainy, chalky, dry, and unappealing" even when the product did not actually contain any soy ingredients.[92] Foods containing soy are also generally thought by U.S. consumers to be more "healthy tasting."[92] Ratings reflect the amount of soy consumed by a given individual.

The potential public health benefit of modest soy consumption during childhood and adolescence cannot be overstated.

Soy Protein and Allergies

Essentially all food proteins have the potential to cause allergic reactions in some individuals. Although soy protein is one of the eight food proteins responsible for approximately 90 percent of all allergic reactions, these eight foods are not equally allergenic. The number of adults allergic to soy is quite small.[93] In fact, a recent estimate found that milk allergy was 40-fold more common than allergy to soy protein.[93]

The relative number of children allergic to soy protein is almost certainly higher than the number of adults because children are much more sensitive to dietary proteins in general.[94] However, most children are thought to outgrow their soy allergies early on in life,[94] although the pace at which this occurs is a matter of some recent discussion.[95] One study reported that more than 80 percent of infants outgrew their soy allergy by 2 years of age[96] whereas a more recent study found 70 percent of children outgrow their soy allergies by age 10.[97] The higher the baseline soy-specific serum IgE levels, the longer it takes for this to occur.

Isoflavones in Children's Diets

Preliminary data suggest that children absorb isoflavones to a greater extent than adults.[98] Although soyfoods have been consumed by Asian children for centuries without any apparent adverse effects, there is much interest in identifying the biological effects of isoflavones in children. One study with this aim examined the effects of isoflavones on high-density lipoprotein (HDL) levels in boys.[99] HDL levels decrease in boys as they enter puberty whereas no such decrease occurs in girls, a difference that may be due to the higher estrogen levels in females. Thus, it was hypothesized that isoflavone exposure would raise HDL levels in boys. However, no such changes occurred; thus, at least for this one possible measure of estrogenicity, no effects were noted. In agreement, research shows that soy protein has no effect on circulating testosterone[100] or estrogen levels in men.[101-109]

There is also increasing interest in understanding the impact of diet on pubertal development because of research indicating that pubertal characteristics are occurring at an earlier age in American girls.[110, 111] One line of thought is that exposure to xenoestrogens, including phytoestrogens, may be a factor in the advancing age of menarche. For this reason, there is interest in determining whether soy intake affects pubertal development. There is little to no research that can provide insight into this question although recent epidemiologic studies have found that both total and animal protein is associated with earlier menarche and the development of early pubertal characteristics.[112, 113]

One adverse effect associated with earlier puberty in girls is an increased risk of developing breast cancer later in life. While the effect of soy on puberty has not been studied, there is an impressive body of research, consisting of both epidemiologic[114-117]

and animal[118, 119] data, indicating that that soy intake when young reduces breast cancer risk later in life. This evidence is consistent with mounting data that early life events greatly impact breast cancer risk.[120] The first 20 years of life appear to be particularly important.[121]

Research from the University of Alabama has shown that when rats are given the primary isoflavone in soybeans for just a few weeks early in life and then put on a typical laboratory diet, they develop 50 percent fewer tumors than rats not given this isoflavone.[118] Isoflavone exposure causes mammary cells to be changed in a way that makes them permanently less likely to be transformed into cancer cells later in life.[122] The protective effects of early pregnancy against breast cancer appear to work through a similar mechanism.[120] The epidemiologic data suggest that quite modest amounts (perhaps just 1 serving per day) of soy during the early years are likely sufficient to reduce breast cancer risk.[114-117] The period of exposure to soy that is theoretically most protective against breast cancer is unclear. Although most studies have focused on the teenage years,[114, 115, 117] the results from a small study by Korde et al.[116] suggest soy consumption during childhood may be even more protective.

Epidemiologic data suggests that modest amounts (perhaps just one serving per day) of soy during the early years are likely sufficient to reduce breast cancer risk.

Summary and Conclusions

Establishing good eating habits early in life is important. Childhood dietary intake may impact adult chronic disease risk and influence eating habits in adulthood. Soyfoods provide important options for improving the diets of young people, and research shows that these foods are accepted and enjoyed by children.

Therefore, soyfoods can be viewed as healthy additions to the diets of children and adolescents. Other than relatively rare soy protein allergy, there is no clinical evidence that soyfoods exert any adverse effects. To the contrary, there is evidence suggesting that exposure to soy during childhood and adolescence reduces breast cancer risk later in life.

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