Organic Foods: Health and Environmental Advantages and Disadvantages

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CLINICAL REPORT

Organic Foods: Health and Environmental Advantages and Disadvantages

abstract

FREE

The US market for organic foods has grown from $3.5 billion in 1996 to $28.6 billion in 2010, according to the Organic Trade Association. Organic products are now sold in specialty stores and conventional supermarkets. Organic products contain numerous marketing claims and terms, only some of which are standardized and regulated.

In terms of health advantages, organic diets have been convincingly demonstrated to expose consumers to fewer pesticides associated with human disease. Organic farming has been demonstrated to have less environmental impact than conventional approaches. However, current evidence does not support any meaningful nutritional benefits or deficits from eating organic compared with conventionally grown foods, and there are no well-powered human studies that directly demonstrate health benefits or disease protection as a result of consuming an organic diet. Studies also have not demonstrated any detrimental or disease-promoting effects from an organic diet. Although organic foods regularly command a significant price premium, well-designed farming studies demonstrate that costs can be competitive and yields comparable to those of conventional farming techniques. Pediatricians should incorporate this evidence when discussing the health and environmental impact of organic foods and organic farming while continuing to encourage all patients and their families to attain optimal nutrition and dietary variety consistent with the US Department of Agriculture's MyPlate recommendations.

This clinical report reviews the health and environmental issues related to organic food production and consumption. It defines the term "organic," reviews organic food-labeling standards, describes organic and conventional farming practices, and explores the cost and environmental implications of organic production techniques. It examines the evidence available on nutritional quality and production contaminants in conventionally produced and organic foods. Finally, this report provides guidance for pediatricians to assist them in advising their patients regarding organic and conventionally produced food choices. *Pediatrics* 2012;130:e1406–e1415

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KEY WORDS

organic food, produce, meat, dairy, growth hormone, antibiotic, farming, diet

ABBREVIATIONS

GH—growth hormone
NOP—National Organic Program
USDA—US Department of Agriculture

The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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DEFINITION AND REGULATION OF ORGANIC FOODS

Definition

Organic farming uses an approach to growing crops and raising livestock that avoids synthetic chemicals, hormones, antibiotic agents, genetic engineering, and irradiation. In the United States, the US Department of Agriculture (USDA) has implemented the National Organic Program (NOP)[1] in response to the Organic Foods Production Act of 1990.[2] The NOP set labeling standards that have been in effect since October 2002. NOP standards for organic food production include many specific requirements for both crops and livestock. To qualify as organic, crops must be produced on farms that have not used most synthetic pesticides, herbicides, and fertilizer for 3 years before harvest and have a sufficient buffer zone to decrease contamination from adjacent lands. Genetic engineering, ionizing radiation, and sewage sludge is prohibited. Soil fertility and nutrient content is managed primarily with cultivation practices, crop rotations, and cover crops supplemented with animal and crop waste fertilizers. Pests, weeds, and diseases are managed primarily by physical, mechanical, and biological controls instead of with synthetic pesticides and herbicides. Exceptions are allowed if substances are on a national approved list. Organic livestock must be reared without the routine use of antibiotic agents or growth hormones (GHs) and must be provided with access to the outdoors. If an animal is treated for disease with antibiotic agents, it cannot be sold as organic. Preventive health practices include vaccination and vitamin and mineral supplementation. The USDA certifies organic products according to these guidelines. Organic farmers must apply for certification, pass a test, and pay a fee. The NOP requires annual inspections to ensure ongoing compliance with these standards.

Labeling

Consumers are confronted with a wide range of food product marketing terms, some regulated and some not (Table 1). The labeling requirements of the NOP apply to raw, fresh products and processed products that contain organic agricultural ingredients. These labeling requirements are based on the percentage of organic ingredients in a product.[3] Products labeled "100% organic" must contain only organically produced ingredients and processing aids (excluding water and salt). Products labeled "organic" must consist of at least 95% organically processed ingredients (excluding water and salt); the remaining 5% of ingredients may be conventional or synthetic but must be on the USDA's approved list. Processed products that contain at least 70% organic ingredients can use the phrase "made with organic ingredients" and list up to 3 of the organic ingredients or food groups on the principal display panel. For example, soup made with at least 70% organic ingredients and only organic vegetables may be labeled either "soup made with organic peas, potatoes, and carrots" or "soup made with organic vegetables."

Related Terms

The NOP places no restrictions on the use of truthful labeling claims, such as "no drugs or growth hormones used," "free range," or "sustainably harvested."[3] The USDA regulates the term "free range" for poultry products; to use this term, producers must demonstrate that the poultry has been allowed "access to the outside."[4] According to Consumers Union's evaluation, this means that a poultry product comes from a bird that had at least 5 minutes of access to the outdoors each day.[4,5] No standard definition exists for all other products

TABLE 1 Commonly Used Food Product Marketing Terms

Term	Definition
100% organic	Must contain only organically produced ingredients and processing aids (excluding water and salt).
Organic	Must consist of at least 95% organically produced ingredients (excluding water and salt). Any remaining product ingredients must consist of nonagricultural substances approved on the National List.
Made with organic ingredients	Must contain at least 70% organic ingredients.
Natural	A product containing no artificial ingredient or added color and that is only minimally processed (a process that does not fundamentally alter the raw product). The label must explain the use of the term.
Free range	Producers must demonstrate to the USDA that the poultry has been allowed access to the outside.
No hormones (pork or poultry)	Hormones are not allowed in raising hogs or poultry. Therefore, the claim "no hormones added" cannot be used on the labels of pork or poultry unless it is followed by a statement that says "Federal regulations prohibit the use of hormones."
No hormones (beef)	The term "no hormones administered" may be approved for use on the label of beef products if sufficient documentation is provided to the USDA by the producer showing no hormones have been used in raising the animals.
No antibiotics (red meat and poultry)	The terms "no antibiotics added" may be used on labels for meat or poultry products if sufficient documentation is provided by the producer to the USDA demonstrating that the animals were raised without antibiotics.
Certified	"Certified" implies that the USDA's Food Safety and Inspection Service and the Agriculture Marketing Service have officially evaluated a meat product.
Chemical free	This term is not allowed to be used on a label.

There are no restrictions on use of other truthful labeling claims, such as "no drugs or growth hormones used," or "sustainably harvested."

carrying the "free range" label, such as beef, pork, or eggs; the use of the term, however, is allowed.

The term "natural" or "all natural" is defined by the USDA for meat and poultry and means that the products contain no artificial flavoring, color ingredients, chemical preservatives, or artificial or synthetic ingredients and are "minimally processed." Minimally processed means that the raw product was not fundamentally altered. Additional USDA definitions of other labeling terms can be found in publicly available USDA fact sheets.[4]

The term "raw" milk refers to unpasteurized milk. All milk certified as organic by the USDA is pasteurized. Raw milk can contain harmful bacteria, such as *Salmonella* species, *Escherichia coli* 0157:H7, *Listeria* species, *Campylobacter* species, and *Brucella* species, and has been repeatedly associated with outbreaks of disease caused by these pathogens. The American Academy of Pediatrics, US Food and Drug Administration, and Centers for Disease Control and Prevention advise consumers not to consume raw milk.[6–8]

SCOPE OF CONSUMER USE, PRICES, AND TRENDS IN ORGANIC FOOD

In 2008, more than two-thirds of US consumers bought some organic products, and more than one-quarter bought organic at least weekly. The amount of US acreage dedicated to organic crops has doubled since 1997.[9] Consumers choose organic food in the belief that organic foods are more nutritious, have fewer additives and contaminants, and are grown more sustainably.[10] Some studies[11,12] suggest that families with children and adolescents or younger consumers in general are more likely to buy organic fruits and vegetables than are other consumers.[13] The factor most consistently associated with the increased propensity to purchase organic food is the level of consumer education.[14–21] Organic products, however, cost up to 40% more.

NUTRITIONAL QUALITY OF ORGANIC VERSUS CONVENTIONAL FOOD

Produce

Consumers believe that organic produce is more nutritious than conventionally grown produce, but the research to support that belief is not definitive. Many studies have demonstrated no important differences in carbohydrate or vitamin and mineral content.[22] Some studies have found lower nitrate content in organic foods versus conventionally grown foods, which is potentially desirable because of the association of nitrates with increased risk of gastrointestinal cancer and, in infants, methemoglobinemia. Higher vitamin C concentrations were found in organic leafy vegetables, such as spinach, lettuce, and chard versus the same conventionally produced vegetables in 21 of 36 (58%) studies.[22] Other studies have found higher total phenols in organic produce versus conventionally grown produce and have postulated health benefits from antioxidant effects.[23]

Several attempts have been made to review the relevant literature and draw conclusions on organic versus conventional foods, but the results are conflicting.[24–28] A large systematic review published in 2009 found that fewer than 20% of 292 articles with potentially relevant titles met criteria for quality, leaving only 55 studies to assess. The authors highlighted the fact that the nutrient content of produce is affected by numerous factors, including the geographic location of the farm, local soil characteristics, climactic conditions that can vary by season, maturity at time of harvest, and storage and time to testing after harvest. Because of the large number of nutrients reported in various articles, the authors grouped the nutrients into large categories. They found no significant differences in most nutrients, with the exception of higher nitrogen content in conventional produce and higher titratable acidity and phosphorus in organic produce.[29] Better-quality research that accounts for the many confounding variables is needed to elucidate potential differences in nutrients and the clinical importance of nutrients that may be different. At this time, however, there does not appear to be convincing evidence of a substantial difference in nutritional quality of organic versus conventional produce.

Milk

The composition of dairy products, including milk, is affected by many factors, including differences caused by genetic variability and cattle breed; thus, the results of studies assessing milk composition must be interpreted with caution. In general, milk has the same protein, vitamin, trace mineral content, and lipids from both organically and conventionally reared cows. Fat-soluble antioxidants and vitamins present in milk come primarily from the natural components of the diet or from the synthetic compounds used to supplement the feed ingested by lactating cows.[30]

One recent study examined antibiotic and microorganism content, hormone concentrations, and nutritional values of milk in 334 samples from 48 states labeled as organic, not treated with bovine GH (referred to as "GH-free"), or conventional. This study found that milk labeled "conventional" had lower bacterial counts than milk that was organic or GH-free, although this was not clinically significant. Estradiol and progesterone concentrations were lower in conventional milk than in organic milk, but GH-free milk had progesterone concentrations similar to conventional milk and estradiol concentrations similar to organic milk. Macronutrient composition was similar, although organic milk had 0.1% more protein than the other 2 milk types.[31]

Several studies have demonstrated that organic milk has higher concentrations of antioxidants and polyunsaturated fatty acids. However, it is important to recognize that the composition of milk is strongly related to what the cows eat. This differs by time of year (outdoors in the summer, indoor forage in the winter) and whether the farms are high or low input. High-input farms supplement the diets of cattle with proprietary minerals and vitamins. Low-input farms use methods similar to those used in organic farming but do not follow all the restrictions prescribed by organic farming standards; they use mineral fertilizers but at lower levels than used by conventional high-input systems. One study comparing milk from all 3 production systems found milk from both the low-input organic and low-input nonorganic systems generally had significantly higher concentrations of nutritionally desirable unsaturated fatty acids (conjugated linoleic acid and omega-3 fatty acids) and fat-soluble antioxidants compared with milk from the high-input systems; milk derived from cows in both organic certified and nonorganic low-input systems was significantly higher in conjugated linoleic acid content than was milk from conventional high-input systems.[32]

HORMONES

GH

Hormone supplementation of farm animals, especially with GH, is one of the major reasons consumers state they prefer to buy organic foods. Bovine GH (ie, recombinant bovine somatotropin) increases milk yield by 10% to 15% and is lipotropic in cows. Because GH is degraded in the acidic stomach environment, it must be given by injection. GH is species-specific, and bovine GH is biologically inactive in humans. Because of this, any bovine GH in food products has no physiologic effect on humans, even if it were absorbed intact from the gastrointestinal tract. In addition, 90% of bovine GH in milk is destroyed during the pasteurization process. There is no evidence that the gross composition of milk (fat, protein, and lactose) is altered by treatment with bovine GH, nor is there any evidence that the vitamin and mineral contents of milk are changed by GH treatment.[31]

GH treatment of cows may actually have environmental benefits. GH increases milk production per cow, which could theoretically decrease the number of cows needed to produce a given amount of milk, with resultant need for fewer cows and, thus, less cultivated land needed to feed the cows. In addition, fewer cows would result in the production of less manure with resultant reduced methane production and less carbon dioxide production, with a resultant salutary effect on global warming.[33]

Sex Steroids

Treatment of cattle with sex steroids increases lean muscle mass, accelerates the rate of growth, and is an efficient way to increase meat yield. Estrogens are usually given by implantation of estrogen pellets into the skin on the underside of the ear, and the ear is discarded during slaughter. Unlike GH, sex steroids are not species-specific and may be given orally without degradation in the stomach. In 1998, the Food and Agriculture Organization of the United Nations and World Health Organization jointly concluded that meat from estradiol-treated animals was safe on the basis of data obtained from residue levels in meat from studies performed in the 1970s and 1980s using radioimmunoassay methods. One study demonstrated concentrations of estrogens found in meat residues were low and overlapped with concentrations found in untreated cows.[34] Gas chromatography measurements of sex steroids progesterone, testosterone, 17β estradiol, and estrone and their metabolites in meat products, fish, poultry, milk, and eggs revealed insignificant amounts compared with daily production of these steroids in adults and children.[35] Furthermore, 98% to 99% of endogenous sex steroids are bound by sex-hormone-binding globulin, rendering them metabolically inactive as only the unbound (free) forms of sex steroids are metabolically active. Synthetic sex steroids (zeranol, melengestrol, and trenbolone) commonly used in animals have lower affinities to sex-hormone-binding globulin and, therefore, are potentially more metabolically active unbound sex steroids. These hormones do not occur naturally in humans, and although the concentrations of these hormones are low in cattle, the biological effects in humans, if any, are unknown.

Ingestion of milk from estrogen-treated cows appears to be safe for children. Estradiol and estrone concentrations in organic and conventional 1%, 2%, and whole milk were the same, although the concentrations of sex steroids were higher as the fat content of the milk increased and were lower than endogenous production rates in humans. Estradiol concentrations in milk ranged from 0.4 to 1.1 pg/mL, and estrone concentrations ranged from 2.9 to 7.9 pg/mL, with the lowest concentrations in skim milk and the highest in whole milk.[36]

Endogenous estradiol concentrations are as high as 80 pg/mL in 2- to 4-month-old female infants and 40 pg/mL in 2- to 4-month-old male infants. Human milk has estradiol concentrations as high as 39 pg/mL and estrone (which has approximately half the potency of estradiol) concentrations as high as 1177 pg/mL. Human colostrum has even higher estrogen concentrations of 500 pg/mL and 4000 to 5000 pg/mL for estradiol and estrone, respectively. Cow milk, by comparison, has estradiol concentrations of 4 to 14 pg/mL and estrone concentrations of 34 to 55 pg/mL.[37,38]

It has been postulated that ingested estrogen in food derived from sex-hormone-treated animals may play a role in earlier development of puberty and increasing risk of breast cancer. However, no studies have supported this hypothesis in humans. Studies in animals demonstrating carcinogenic and teratogenic effects of estrogens used high doses of estradiol and cannot be extrapolated to the low doses of sex steroids found in the food supply. Estrogen concentrations in the myometrium, breast, and vagina of postmenopausal women, although still low, are higher than those found in serum, and additional studies are needed to determine the significance of these low concentrations of sex steroids in estrogen-sensitive tissues.[39]

An association has been found between red meat consumption in high school girls and the development of breast cancer later in life. A 7-year prospective longitudinal study of 39 268 premenopausal women 33 to 53 years of age who filled out a comprehensive diet history of foods eaten while in high school in the 1960s and 1970s revealed a linear association between each additional 100 g of red meat consumed in high school per day with the risk of developing hormone-receptor-positive premenopausal tumors (relative risk, 1.36; 95% confidence interval, 1.08–1.70; P = .008). Red meat ingestion did not increase the risk of hormone-receptor-negative tumors. Although this intriguing study, which suggested that higher red meat consumption in adolescence may increase breast cancer risk, tracked cases of cancer prospectively after the dietary history was obtained, it was limited by a number of factors, including the dependence on subjects' long-term memory of amount of food eaten decades previously, the likelihood that hormone concentrations in meat were higher in that period, and the lack of direct measurement of hormonal exposure.[40] Longitudinal prospective studies are needed to compare the risk of breast cancer in women who eat meat from hormone-treated animals with the risk in women who eat meat from untreated animals.

Endocrine disrupters, chemicals that interfere with hormone signaling systems, are pervasive in our environment. Among the most commonly found endocrine disrupters are bisphenol A, found in industrial chemicals and plastics; phthalates, found in personal care items such as cosmetics; and lavender and tea tree oil, found in many hair products, soaps, and lotions; all have estrogenic properties. Endocrine disrupters are postulated to be involved in the increased occurrence of genital abnormalities among newborn boys and precocious puberty in girls. Recent literature on sex steroid concentrations and their physiologic roles during childhood indicate that concentrations of estradiol in prepubertal children are lower than originally thought and that children are extremely sensitive to estradiol and may respond with increased growth and/or breast development even at serum concentrations below the current detection limits.[41] No threshold has been established below which there are no hormonal effects on exposed children. Furthermore, the daily endogenous production rates of sex steroids in children estimated by the Food and Drug Administration in 1999 and still used in risk assessments are highly overestimated and should be reevaluated by using current assays.[41] It is therefore important to determine the relative importance of hormone treatment of animals in the context of other environmental endocrine disrupters through long-term longitudinal studies in children.

NONTHERAPEUTIC USE OF ANTIBIOTIC AGENTS

Conventional animal husbandry frequently includes the administration of antibiotic agents in nontherapeutic doses to livestock to promote growth and increase yields. Between 40% and 80% of the antimicrobial agents used in the United States each year are used in food animals, three-quarters of which is nontherapeutic. Many of these agents are identical or similar to drugs used in humans.[42] Evidence is clear that such nontherapeutic use promotes the development of drug-resistant organisms in the animals and that these organisms then colonize the intestines of people living on farms where this practice occurs.[43] Evidence is also ample that human disease caused by antibiotic-resistant organisms spread through the food chain.[44] Because organic farming prohibits the nontherapeutic use of antibiotic agents, it could contribute to a reduction in the threat of human disease caused by drug-resistant organisms.

SYNTHETIC CHEMICAL EXPOSURE

Pesticides

Pesticides have a host of toxic effects that range from acute poisonings to subtle subclinical effects from long-term, low-dose exposure.[45] Organophosphate pesticides are commonly used in agriculture, and poisoning is a persistent problem in the agricultural setting. From 1998 to 2005, 3271 cases of agricultural occupational acute pesticide poisoning were reported to the California Department of Pesticide Regulation and the National Institute of Occupational Health's SENSOR-Pesticides program. This constitutes a rate of 56 cases per 100 000 full-time equivalents, 38 times the rate observed in nonagricultural occupations.[46] Chronic exposure among farm workers has been associated with numerous adult health problems, including respiratory problems, memory disorders, dermatologic conditions, depression, neurologic deficits including Parkinson disease, miscarriages, birth defects, and cancer.[47–50] Prenatal organophosphate pesticide exposure has been associated with adverse birth outcomes, such as decreased birth weight and length[51] and smaller head circumference.[52] A large prospective birth cohort study that measured pesticide exposure in pregnant farm workers in California and followed their offspring found lower mental development index scores at 24 months of age[53] and attentional problems at 3.5 and 5 years of age.[54] An analysis of cross-sectional data from the NHANES has demonstrated that within the range of exposure in the general US population, the odds of attention-deficit/hyperactivity disorder for 8- to 15-year-old children were increased 55% with a 10-fold increase in urinary concentrations of the organophosphate metabolite dimethyl alkylphosphate.[55]

The National Research Council reported in 1993 that the primary form of exposure to pesticides in children is through dietary intake.[56] Organic produce consistently has lower levels of pesticide residues than does conventionally grown produce,[57] and a diet of organic produce reduces human exposure. Several studies have clearly demonstrated that an organic diet reduces children's exposure to pesticides commonly used in conventional agricultural production. A small longitudinal cohort of children who regularly consumed conventional produce demonstrated that urinary pesticide residues were reduced to almost nondetectable levels (below 0.3 μg/L for malathion dicarboxylic acid, for example) when they were changed to an organic produce diet for 5 days.[58] In addition, residues varied with seasonal intake of produce, suggesting that dietary intake of organophosphate pesticides represented the major source of exposure in these young children.[59]

Although a common practice, rinsing conventionally farmed produce reduces some but not all pesticide residues on produce to varying degrees but has not been proven to decrease human exposure.[60]

Pesticide metabolite concentrations observed in studies that examined exposure in farming communities as well as in residential settings were in the same range as those observed in subjects consuming conventional produce in studies of biological exposure measures for organic versus conventional produce diets. For instance, the median concentration observed for malathion urinary metabolites in female farm workers whose offspring had significantly lower mental development index scores at 24 months of age was 0.82 μg/L,[53] which is close to the median concentration found in children in the initial conventional diet phase of the organic diet study of 1.5 μg/L, discussed previously.[58] Ranges for other pesticide metabolites were similar.

Although chronic pesticide exposure and measurable pesticide metabolite concentrations seem undesirable and potentially unhealthy, no studies to date have experimentally examined the causal relationship between exposure to pesticides directly from conventionally grown foods and adverse neurodevelopmental health outcomes. Most of the research implicating pesticides in these adverse health outcomes is from case-control or cross-sectional studies. These studies are limited by a number of factors, including difficulties measuring past exposures and the lack of a positive temporal relationship between exposure and outcome. It is difficult to directly extrapolate from these studies and draw conclusions about potential toxicity at the levels of pesticide exposure documented from dietary intake of conventional produce. Data derived from large prospective cohort studies may address some of these shortcomings.

ENVIRONMENTAL IMPACT AND PRODUCTION EFFICIENCY OF ORGANIC VERSUS CONVENTIONAL FARMING METHODS

Environmental Impact

A major subject in the organic debate is whether organic farming methods have less impact on the environment, can be equally as productive, and can be no more expensive than conventional approaches. A variety of surveys and studies have attempted to compare these issues for organic and conventional farming methods. Many believe that organic farming is less damaging to the environment because organic farms do not use or release synthetic pesticides into the environment, some of which have the potential to harm soil, water, and local terrestrial and aquatic wildlife.[61] In addition, it is thought that organic farms are better than conventional farms at sustaining diverse ecosystems, including populations of plants, insects, and animals, because of practices such as crop rotation. When calculated either per unit area or per unit of yield, organic farms use less energy and produce less waste.[62,63] Organically managed soil has been demonstrated to be of higher quality and have higher water retention, which may increase yields for organic farms in drought years.[64]

Production Efficiency

Critics of organic farming methods believe that organic farms require more land to produce the same amount of food as conventional farms. One study found a 20% smaller yield from organic farms.[65] Another study from the Danish Environmental Protection Agency found that, area for area, organic farms of potatoes, sugar beets, and seed grass produce as little as half the output as their conventional farm counterparts.[66]

It remains controversial whether organic farming is able to provide adequate food supply to sustain the world population. Norman Borlaug, considered to be the father of the "green revolution" and winner of the Nobel Peace Prize, believes that organic farming alone is incapable of feeding the world population and needs to be used in conjunction with genetically modified food.[67] On the other hand, a meta-analysis of 292 studies designed to assess the efficiency of both organic and conventional farming concluded that organic methods could produce enough food on a global per-capita basis to sustain the current human population and potentially an even larger population without increasing the agricultural land base.[68]

The largest prospective farming study to date is a comparative trial of more than 20 years' duration conducted by researchers from Cornell University. This study, conducted in Pennsylvania, compared various conventional and organic farming approaches in a controlled prospective design in which confounding influences such as weather and moisture were similar in the different systems. Over 20 years of observation, the organic fields had productivity that was generally comparable to the conventional fields, while avoiding environmental pollution with herbicides and pesticides and reducing fossil fuel consumption by 30%. Although costs were higher primarily because of increased labor costs (15%), the return for the organic plots was higher because of the higher prices commanded at the marketplace.[64]

THE DIFFERENCE IN PRICE OF ORGANIC VERSUS CONVENTIONAL FOODS

One major concern with organic food is its higher price to consumers. Organic products typically cost 10% to 40% more than similar conventionally produced products.[69] A number of factors contribute to these higher costs, including higher-priced organic animal feed, lower productivity, and higher labor costs because of the increased reliance on hand weeding. Of potential concern is that the higher price of organically produced fruits and vegetables might lead consumers to eat less of these foods, despite the well-established literature documenting the health benefits of eating fruits and vegetables, including lower rates of obesity, cardiovascular disease, and certain types of cancer. Fifty-five percent of children born in the United States are eligible for food packages under the Special Supplemental Nutrition Program for Women, Infants, and Children, and these food packages are currently giving families approximately $10 a month to spend on fruits and vegetables, so the money must be used wisely to maximize spending capacity for healthy foods.

SUMMARY

To demonstrate superiority of 1 food production method over another, it is important to show an advantage in terms of improved individual health or an important societal advantage. Organic diets have been convincingly demonstrated to expose consumers to fewer pesticides associated with human disease. Nontherapeutic use of antibiotic agents in livestock contributes to the emergence of resistant bacteria; thus, organic animal husbandry may reduce the risk of human disease attributable to resistant organisms. There is sound evidence that organic foods contain more vitamin C (ascorbic acid) and phosphorus than do conventional foods, but there is no direct evidence that this provides meaningful nutritional benefits to children eating organic foods compared with those who eat conventionally grown food products. Well-designed farming studies demonstrate that comparable yields can be achieved with organic farming techniques and that organic farming has a lower environmental impact than do conventional approaches. However, no well-powered human studies have directly demonstrated health benefits or disease protection as a result of consuming an organic diet. Such studies would be difficult to perform and require large prospective cohort populations or, better, randomly assigning subjects to interventions that increase organic versus conventional food intakes. Additional data are needed to identify relationships between diet and pesticide exposure and individual health outcomes. Pediatricians should incorporate this evidence when discussing the health and environmental impact of organic foods and organic farming while continuing to encourage all patients and their families to attain optimal nutrition and dietary variety by choosing a diet high in fresh fruits and vegetables, consistent with the USDA's MyPlate recommendations.

Key Points

1. Nutritional differences between organic and conventional produce appear minimal, but studies examining this have been limited by inadequate controls for the many subtle potential confounders, such as moisture, maturity of the produce, and measurement techniques.

No direct evidence of a clinically relevant nutritional difference between organic and conventional produce exists.

2. Organic produce contains fewer pesticide residues than does conventional produce, and consuming a diet of organic produce reduces human exposure to pesticides. It remains unclear whether such a reduction in exposure is clinically relevant.
3. Organic animal husbandry that prohibits the nontherapeutic use of antibiotic agents has the potential to reduce human disease caused by drug-resistant organisms.
4. There is no evidence of clinically relevant differences in organic and conventional milk.
   a. There are few, if any, nutritional differences between organic and conventional milk. There is no evidence that any differences that may exist are clinically relevant.
   b. There is no evidence that organic milk has clinically significant higher bacterial contamination levels than does conventional milk.
   c. There is no evidence that conventional milk contains significantly increased amounts of bovine GH. Any bovine GH that might remain in conventional milk is not biologically active in humans because of structural differences and susceptibility to digestion in the stomach.
5. Organic farming approaches in practice are usually more expensive than conventional approaches, but in carefully designed experimental farms, the cost difference can be mitigated.
6. The price differential between organic and conventional food might be reduced or eliminated as organic farming techniques advance and as the prices of petroleum products, such as pesticides and herbicides, as well as the price of energy, increase.
7. Organic farming reduces fossil fuel consumption and reduces environmental contamination with pesticides and herbicides.
8. Large prospective cohort studies that record dietary intake accurately and measure environmental exposures directly will likely greatly enhance understanding of the relationship between pesticide exposure from conventional foods and human disease and between consumption of meat from hormone-treated animals and the risk of breast cancer in women.

Advice for Pediatricians

1. Encourage patients and their families to eat an optimally health-promoting diet rich in fruits, vegetables, whole grains, and low-fat or fat-free milk and dairy products.
2. When approached by families interested in consuming organic foods, review key facts presented in this report to address the full range of relevant nutrition, human health, environmental, and cost issues. Be explicit about areas in which scientific evidence is strong as well as those in which it is uncertain.
3. When advice is sought by families concerned with the potential health impact of pesticide residues in food, direct them toward reliable resources that provide information on the relative pesticide content of various fruits and vegetables. Two such examples include:
   a. *Consumer Reports* article (September 2008) "Fruits and Vegetables, When to Buy Organic" (http://www.consumerreports.org/health/healthy-living/diet-nutrition/healthy-foods/organic-foods/overview/when-to-buy-organic.htm) and
   b. Environmental Working Group's "Shopper's Guide to Pesticides" (http://www.foodnews.org).

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