Office of Evidence Based Practice – Community Specific Care Question
Organic Foods

Specific Care Question:
In children, is it beneficial to purchase organic foods versus conventionally grown foods in terms of (a) improved nutrient quality, (b) decreased exposure to pesticides, (c) behavior changes, or (d) environmental impact of food production?

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Significance and importance of the question:

Community health care providers are often asked to weigh-in on a family's decision to purchase organic foods over conventionally grown foods. The balance of good nutrition, potential adverse effects of chemicals used to produce a plentiful and low pest food supply versus the increased cost of foods grown without synthetic fertilizers or pesticides is an important decision for families.

Definitions: The term "organic" needs to be understood for what it means, as well as what it does not mean. Here is a useful chart:

Term	USDA definition	
Organic	All crops, livestock and agricultural products are produced with methods that foster recycling of resources, promote ecological balance, and conserve biodiversity. Synthetic fertilizers, sewage sludge, irradiation, and genetic engineering may not be used.	There is a list of over 50 nonagricultural (nonorganic substances allowed as ingredients in or on processed products labeled as "organic" or "made with organic (specified ingredients of food group(s)).
Terms that are **not** organic, but supposed by some to mean the same	Free-range- labeling is regulated- specifically to birds, continuous access to the outdoors (may be netted or fenced)	Do not have to feed organic feed
	Cage-free- labeling is regulated- specifically to birds, freely able to roam a building, room or enclosed area with unlimited access to food and fresh water	Do not have to feed organic feed
	Natural- labeling is regulated- meat, poultry, and egg products. Natural means minimally processed, no artificial ingredients	You can have non-organic "natural" products
	Grass fed- majority of nutrients from grass, does not limit use of antibiotics, hormones or pesticides.	Livestock designated organic can be fed grain, but it has to be organic grain free of synthetic fertilizers, sewage sludge, irradiation and genetic engineering
	Pasture raised- labeling is not regulated, anyone can use it. Humane- labeling is not regulated, anyone can use it.	

Source: USDA, National Organic Program (2011)

Search Strategy and Results:

Pubmed:

("Food, Organic"[Mesh] OR "Health Food"[Mesh]) AND ("Pesticide Residues"[Mesh] OR "Pesticides"[Mesh] OR "Agrochemicals"[Mesh] OR "Nitrates"[Mesh] OR "Attention Deficit Disorder with Hyperactivity"[Mesh]) AND (Humans[Mesh] AND (Meta-Analysis[ptyp] OR Practice Guideline[ptyp] OR Randomized Controlled Trial[ptyp] OR Review[ptyp] OR Comparative Study[ptyp] OR Research Support, American Recovery and Reinvestment Act[ptyp] OR Research Support, N I H, Extramural[ptyp] OR Research Support, N I H, Intramural[ptyp] OR Research Support, Non U S Gov't[ptyp] OR Research Support, U.S. Government[ptyp] OR Research Support, U S Gov't, Non P H S[ptyp] OR Research Support, U S Gov't, P H S[ptyp]) AND English[lang])

20 papers were identified.

Included studies: Nine studies are included. Two systematic reviews, three cohort studies, two crossover design, one survey, and two non-human cohort studies.

Excluded studies: Eleven studies were excluded. Four studies were not applicable to the question: (a) referred to plant hormone levels in the plants (b) bacteria level in dry-cured sausage and (c) two studies investigated human semen quality in responses to the consumption of conventional vs. organic foods. Seven were narrative reviews.

Method Used for Appraisal and Synthesis:
The Critically Appraised Topic worksheet was used to synthesize the information.

Recommendations:
A recommendation cannot be made based on the studies performed at this time. The evidence neither supports nor refutes the use of foods produced organically versus those produced by conventional methods.

However, due to the concern families may have on this topic, the work of the Environmental Working Group (EWG) may be helpful. EWG is a non-profit organization that advocates protecting U.S. consumers from the effects of known and potential contaminants from food. Although they have known bias, the Shopper's Guide to Pesticides in Produce appears to be a reasonable approach to take with families who are concerned about the health effects of conventionally grown foods. They propose a pragmatic approach to this dichotomy. First, eating fruits and vegetables grown using conventional methods is better than eating no produce at all. Second, they identify twelve fruits and vegetables that contain the most pesticide residue. They call them the "Dirty Dozen" and include: apples, celery, strawberries, peaches, spinach, nectarines (imported), grapes (imported), sweet bell peppers, potatoes, blueberries (domestic), lettuce and kale/collard greens. They also offer a list of foods least likely to retain pesticide residues. The complete lists can be found at http://www.ewg.org/foodnews/summary/

Regardless if produce is grown by organic or conventional farming practices, remind your families to wash all produce thoroughly to remove as much dirt, pesticide residue and microbes as possible.

Summary:

Question 1: Improved nutrient quality. Although the systematic reviews are of high quality and there appears to be no difference in the nutrient quality of foods produced by either organic or conventional farming methods, the quality of the individual studies included in the systematic reviews are low. Further research is likely to have and important influence on our confidence in the estimate of effect, and may change the estimate.

Two systematic reviews have been reported on this question. Dangour (2009), reported on papers that compared nutrient content of foods grown using organic methods, and those grown using conventional methods. Heterogeneity of in crops and livestock studied, and the methods used collect and data makes the data very difficult to interpret. However, no difference was found in the Vitamin C, phenolic compounds, magnesium, potassium, calcium, zinc, copper and total soluble solids content of crops grown by each method. Nitrogen was higher in conventionally grown crops and phosphorus and titratable acidity were higher in organic crops. Differences in nitrogen and phosphorus are attributed to the fertilizers used in each production method. It is plausible organically grown crops have higher titratability because they tend to be harvested closer to the time they were tested. No differences were found in livestock products produced by the farming methods. Dangour (2010) reported on health outcomes of that resulted from the consumption of organic vs. conventional foods. There was vast heterogeneity among the studies and meta- analysis could not be conducted. The largest study reported a relationship between the consumption of organic dairy products and parent reported eczema in infants.

Question 2: Decreased exposure to pesticides, natural toxins, and microbes. Based on moderate quality evidence, pesticide metabolites are higher in children who consume conventional foods over organic foods. Both studies that evaluated the foods (crops and livestock) found all natural toxins and microbes to be below regulatory levels, and appear to be related to the specific farm or producer, not the method. However, health effects are unknown. Further research, (if performed), is likely to have an important effect on our confidence in the estimate of the effect and may change the estimate.

Five studies are included. Williams (2001) reports that conventional produce buyers have lower perception of the risk of pesticide residue on conventionally grown foods than do organic produce buyers (50/1 Million vs. 200/1 Million). Organic produce buyers have greater perception they can reduce the risk of exposure to pesticides, natural toxins and microbial pathogens by purchasing organic foods. Curl (2003) and Lu (2008) reported on organophosphate

residues in the urine of children fed both conventional and organic foods. In both studies, children who ate predominantly greater amounts of conventional foods had significantly higher levels of urinary pesticide metabolites. The Ghidini (2005) study evaluated milk and meat from six organic and six conventional farms. Although samples from single producers showed contamination with pesticides (p,p' DDE from a conventional farm) microbial pathogens (aflatoxin M1 from an organic farm) all were below the regulated maximum level (Italy). Hoogenboom (2008) assessed products grown on organic vs. conventional farms in the Netherlands. Mirroring the previous study, all levels of pesticide metabolites were less than the regulated maximum level. Pesticide residue, along with natural toxins, microbes were not different between groups.

Question 3: Behavior changes: Based on low quality evidence (observational cohort studies), pesticide metabolites are positively correlated to the odds of attention problems and decreased attention scores in young children. However, other alternatives may be equally reasonable. Further research is likely to have an important influence on our confidence in the estimate of effect and is likely to change the estimate.

Two studies are included for this question. Bouchard (2010) funded by the Canadian NIH is a cohort study that is based on NHANES data. It concluded the odds of meeting the DISC-IV criteria for ADHD increased as urinary concentrations for total diacyl phosphates increased. However, exposure to other environmental organophosphates (home cleaning products) was not included as a variable. The second study, Marks (2010) was funded by the US Environmental Protection Agency, the National Institute of Environmental Health Sciences and the National Institute for Occupational Safety and Health. In this prospective birth cohort study, maternal urinary pesticide metabolite concentrations were positively correlated with the odds of scoring > 70% on the ADHD Confidence Index (clinically classified ADHD). The levels in the children's urine did not show a correlation to ADHD diagnosis. Organophosphate pesticides are metabolized rapidly and long term exposure was not measured. Further confounding the applicability of the findings, families who live and work in the agricultural communities in the Salinas Valley, California may have increased exposure to organophosphates. This level of exposure may not be applicable to all families in the United States.

Question 4: Environmental impact of food production- No studies identified.

References

Bouchard, M. F., Bellinger, D. C., Wright, R. O., & Weisskopf, M.G. (2010). Attention-deficit/hyperactivity disorder and urinary metabolites of organophosphate pesticides. *Pediatrics, 125*, 6, epub May 17.

Cody, M. & Earl, R. (2009).Advising consumers about organic foods and healthful eating. [Web page]. Academy of Nutrition and Dietetics. Retrieved from: http://www.eatright.org/About/Content.aspx?id=10606

Curl, C. L., Fenske, R. A., Elgethun, K., Organophosphorus pesticide exposure of urban and suburban preschool children with organic and conventional diets. Environ Health Perspect, 111, 3, 377-382.

Dangour, A. D., Lock, K., Hayter, A., Allen, E., & Uuay, R. (2010). Nutrition-related health effects of organic foods: a systematic review. *American Journal of Clinical Nutrition, 92*, 1, Epub May 12.

Environmental Working Group. (2011). EWG's 2011 shopper's guide to pesticides in produce. [Web page]. Retrieved from: http://www.ewg.org/foodnews/summary/

Ghidini, S., Zanardi, E., Battaglia, A., Varisco, G., Ferretti, E., Campanini, G., Chizzolini, R. (2005). Comparison of contaminant and residue levels in organic and conventional milk and meat products from northern Italy. *Food Addit Contam, 22*, 1, 9-14.

Hoogenboom, L. A., Bokhorst, J.G., & Northolt, M. D. (2008). Contaminants and microorganisms in Dutch organic food products: a comparison with conventional products. *Food Addit Contam Part A Chem Anal Control Expo Risk Assess, 25*, 10, 1195-1207.

Lu, C., Barr, D. B., Pearson, M. A., & Waller, L.A. (2008). Dietary intake and its contribution to longitudinal organophosphorus pesticide exposure in urban/suburban children. *Environ Health Perspect, 116*, 4, 537-42.

Marks, A. R., Harley, K., Bradman, A., Kogut, K., Barr, D. B., Johnson, C., Calderon, N. (2010). Organophosphate pesticide exposure and attention in young Mexican-American children: The CHAMACOS study. *Environmental Health Perspectives*, *118,* 12, 1768-1774. doi: 10.1289/ehp.1002056

Mayo Clinic. (2011). Nutrition and healthy eating: Organic foods- are they safer? More nutritious? [Web page]. Retrieved from: http://www.mayoclinic.com/health/organic-food/NU00255

U. S. Department of Agriculture, National Organic Program (2011). Welcome to the National Organic Program. [Web page}. Retrieved from: http://www.ams.usda.gov/AMSv1.0/nop

Williams, P. R., & Hammitt, J. K. (2001). Perceived risks of conventional and organic produce: Pesticides, pathogens and natural toxins. Risk Anal, 21, 2, 319-330.

Excluded studies:

Lu, C., Toepel, K., Irish, R., Fenske, R. A., Barr, D. BB & Bravo, R. (2006). Organic diets significantly lower children's dietary exposure to organophosphorus pesticides. *Environmental Health Perspectives, 114*, 260-263. doi:10.1289/ehp.8418
Reason for exclusion: first 3 months of data that was eventually collected for Lu (2008), which is included above.

LaTorre, A., Leandri, A., & Lolletti, D. (2005). Comparison of health status between organic and conventional products. *Comm. Appl. Biol. Sci, Ghent University,* 71, 3, 351- 363.
Reason for exclusion: There is no indication of variation around the mean for data presented. Stilted translation from Italian; uncertain of accuracy of translation.

Worthington, V. (1998). Effect of agricultural methods on nutritional quality: a comparison of organic with conventional crops. *Alternative Therapies, 4*, 1, 58-69.
Reason for exclusion: Does not state search strategy for included studies, nor how studies were selected for inclusion. Data is presented as mean value only. There is no indication of variation around the mean to make true assessment of difference. Finally, up and down arrows are used throughout the paper to indicate

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Organic Food - Critically Appraised Topic (CAT)

Synthesis of relevant studies:

Author, date, country, and	Groups	Level of Evidence (Oxford)	Research design	Significant results	Limitations

industry of funding					
Improved nutrient quality					
Dangour, (2010) United Kingdom	This systematic review included papers that compared health outcomes that resulted from the consumption/exposure to organic vs. conventional foods.	This systematic review is rigorous. Level 1	Systematic review, unable to do meta-analysis due to heterogeneity of outcomes and data collected. Literature search encompassed January 1958-March 2010	The largest included study reported that proxy-reported consumption of strictly organic dairy products was associated with reduced risk of proxy-reported eczema in infants. The majority of the remaining studies did not report differences in nutrition related health outcomes from the consumption of organic foods vs conventional foods. The primary conclusion is that data is lacking to prove or disprove nutrition related effects from the consumption of either organic or conventional foods.	Vast heterogeneity in the included studies <u>Study hypothesis</u> 8 studies were looking for differences in nutrient concentrations of organic v conventional foods 4 studies were looking for differences in markers for carcinogens, or bioavailability of carotenoids or polyphenolic substances Study design See Level of Evidence column. Subjects: range in subjects was from 6-43 subjects Time Frame: 1-28 days. Unknown duration of exposure for many studies Various approaches to the essays in human and animal samples.
Dangour (2009) United Kingdom	Looked at foods, not people. Crops and livestock	Level 1	Systematic Review	Strong search and article selection. 162 studies, 137 studies related to crops and 25 related to livestock <u>Crops</u> No difference in the following nutrients was discovered: vitamin C, phenolic compounds, magnesium, potassium, calcium, zinc, copper, and total soluble solids. Nitrogen contents were significantly higher in conventionally produced crops	Included articles are of varying quality. Heterogeneity of data is biggest limitation Low number of studies met the designation of satisfactory. The organic certifying body is not identified in 54% of the studies. Definitions of plant cultivar or livestock breed were missing in 20% of the

				Phosphorus and titratable acidity were significantly higher in organically produced crops. Livestock No difference was discovered for fats (unspecified) or ash Differences in nitrogen and phosphorus most likely to the differences in fertilizer Differences in titratable acidity most likely due to the difference in ripeness at harvest.	studies. The database of livestock comparison was limited.
Decreased exposure to pesticides					
Curl (2003) USA Funded by EPA	Organic group N= 18 56% male. Mean age 46 months. Mean weight 17 kgs Use of OP pesticides= 3 families Conventional group N= 21 57% male Mean age 47 months. Mean weight	Harm study Cohort Level 2b	Separated into groups based on 3 day food diaries. - Organic group- > 75% organic fruits and vegetables Outcome: urinary levels of 5 organophosphorus pesticide metabolites	Di-methyl metabolites than children with conventional diets were significantly higher than those on organic diets (Mann Whitney *U*-test, P= 0.0003). Diethyl metabolites were not different between the groups.	24 hour urine sample difficult to obtain. Data was adjusted for missed voids. Problems exist with the procedure used to estimate the doses of the OPs. The assumption was that 100% of consumed OP would be excreted in the urine. There is some evidence that approx 70% excreted by this route is actually excreted in the urine.

	17 kg Use of OP pesticides= 7 families				
Ghidini (2005) Italy	Bench study; milk, and meat from organic and conventional farms were compared	Harm study. Case control study Level 3b	Six conventional farms were coupled with 6 organic farms within 2 km of each other. All farms were in the North of Italy. 1000 ml milk sample was taken from each farm. Meat samples were procured from butcher shops. All animals were < 12 months of age, all samples were from the same muscle the longissimus dorsi, between L2 and L3.	One conventional milk sample had residues of p,p'DDE but at a level lower than the maximum residue level. No other pesticides were detected in the 156 samples No PCBs were detected in organic and conventional milk samples. For the meat samples, although all of the following were below the maximum residue level, 3 organic samples, and one conventional sample contained p.p'DDE (an organochlorine pesticide).The later meat sample also contained PCB all below the maximum residue level. • Heavy metals- • Milk- ○ Lead- no statistical difference ○ Cadmium- no statistical difference • Meat ○ Lead- no statistical difference ○ Cadmium- no statistical difference However the organic samples were lower, just not statistically lower. All meat samples were less than the maximum residue level. Aflatoxin M1- concentration inorganic milk was significantly higher than conventional milk.	Mean levels of aflatoxin M1 were elevated above the Italian legal limit, and were higher in organic milk. Most of problem can be related to a single producer. Next question "is the feed used on this farm from home-grown or imported crops".
Hoogenboo	Vegetable	Not	In vitro	Wheat- Organic wheat tends to have	

m, (2008) Netherlands	products: lettuce, wheat, carrots and potatoes Animal products: eggs, broilers, pigs and cows Grown on either organic or conventio nal farms	human, no level to assign	analysis	lower mycotoxin levels, but is related more to climate than production type (organic v conventional). Lead, mercury and arsenic levels were below detection limits in most samples. Cadmium levels were not different. Lettuce- no samples tested positive for *Salmonella* or *E.coli* O157. Pesticides were not positive on any of the organic lettuces. Levels found on the conventional lettuce were below the residue limits. Nitrate levels were below the residue limits on iceberg lettuce produced outside. Arsenic, lead, and cadmium were below the limits. Carrots: nitrate levels were higher in organic carrots than conventional carrots. Heavy metals and arsenic were below the limits; cadmium levels of organic carrots were close to the lower limit. Potatoes: conventional potatoes were not studied. None of the samples exceeded the lower limit for nitrates, heavy metal, arsenic or cadmium. Pigs: only report on organic pig farms. Only one of 20 samples showed inhibition of bacterial growth on macrolides plate, but below the action level. Lead and mercury levels were below the lower limit.	

Lu (2008) USA Funded by EPA	23 children 3-11 years of age. who consumed a conventional diet. 1 year study	Harm study Level 2b Crossover design	Longitudinal cohort study Subjects were fed their normal diet for a year. In the summer and fall sampling season they were switched to an organic diet for 5 days. For all seasons, urinary metabolites of malathion (MDA) chlorpyifos (TCPy)and other organophosphorus (OP) metabolites	Four subjects withdrew from the study due to difficulties adhering with the data collection procedures. Nineteen total subjects Missing samples decreased from 7% (summer), 5% (fall), 5% (winter) to 3% (spring). Three metabolites are not reported on because they had low detection frequency. In each of the 5 day periods where subjects ate the organic variant of foods normally consumed, urinary MDA values were not detected. In each of the 5 day periods where subjects at the organic variant of foods normally consumed, the urinary TCPy values decreased.	There was low detection frequency for three metabolites diazinon (DEAMPY), coumaphos (CMHC), and methyl pirimiphos (IMPY). Low number of subjects. Rigorous protocol that was difficult to maintain for a year. Subject selection specifically looked for families that could adhere to the protocol. May not represent the intake of the general population.
Williams (2001) USA	N= 1004 surveys were distributed, 711 returned (71% response rate) <u>Organic foods</u>	Harm Study Survey Level 5	A 14 page questionnaire distributed to fresh produce shoppers in 1998. Included grocery stores were matched on geographic	Conventional produce buyers believe that risk of pesticide residue is 50/Million, while organic buyers perceive it is 200/Million. Perception of risk reduction from substituting organic produce is significantly greater in organic food buyers than conventional produce buyers in relation to: pesticide residues, natural toxins, microbial pathogens and farm workers.	Sample contains more females than males Educational level of subjects was > than the community of the stores locations Income level of subjects was > than the community of the stores locations

	group (39% of surveys) Conventional foods group (61% of respondents)		location and average household income. Rigorous survey development		
Behavior changes					
Bouchard, (2010) Funded by Canada Funded by the Canadian NIH	Children 8-15 years of age with diagnosed ADHD	Harm study Cohort Level 2b	Cross Sectional Study using NHANES data	Odds of meeting the DISC-IV criteria for ADHD increased with the urinary concentrations of total diacyl phosphates (DAPs) -Driven dimethyl phosphates (DMAPs) with odds ratios of 1.66 (unadjusted) and 1.55 (adjusted for covariates) -When children taking ADHD medication were included, Odds Ratios (OR) for DMAPs increased to 1.87 (unadjusted) and 1.72 (adjusted)	Cross sectional design -Only 1 spot urine sample: long-term exposure to organophosphates necessary to produce ADHD like behaviors -Cannot rule out other environmental exposures to organophosphates
Marks, (2010) USA	348 Mexican-American women and their children in agricultural region of California. Assessment of mothers was prenatal, and children were	Prognosis Study Cohort Level 2b	Prospective birth cohort – Women 18 and over in their first half of pregnancy were recruited from prenatal clinics serving the farm worker community.	Higher concentrations of organophosphate (OP) metabolites in the urine of pregnant women were associated with increased odds of attention problems and poorer attention scores in their young children. These associations were stronger at 5 years than 3.5 years and stronger in boys than girls. For each 10-fold increase in DAP concentrations, children had five times the odds of scoring >70% on the ADHD Confidence Index (clinically classified ADHD).	OP pesticides are rapidly metabolized and there was no measure of long-term exposure. May not be generalizable to U.S. population because prenatal maternal urinary DAP concentrations were higher than the nationally representative sample of women at childbearing age. Also, some of the measures used for behavior assessment were standardized for the general U.S. population rather

	assessed at ages 3.5 and 5 years.			Children's concurrent total dialcyl phosphates (DAP) and dimethyl phosphate metabolites (DM) levels at 3.5 years and 5 years were unrelated to attention outcomes, but some evidence was observed that child diethyl phosphate metabolite (DE) concentrations at 5 years were adversely related to a composite measure of attention.	than Mexican-Americans.
Environmental impact of food production	No studies identified.				