Transforming Jane Doe's Diet

Charles Benbrook Ph.D.

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1. EXECUTIVE SUMMARY

Smarter, more disciplined food choices can tip the odds toward sustained, good health for the current generation and the next. But how can a person string together a series of smarter food choices day by day, turning a modestly unhealthy diet into a consistently healthy one? And how dramatic must the changes be?

Meet Jane Doe, a 30-year old woman in good health. She is 5' 5" tall and weighs 155 pounds. Her Body Mass Index (BMI) is 25.8, just into the overweight range of BMIs (25 through 29.9). She and her husband are looking forward to starting a family in the near future, and so Jane is paying close attention to her health and nutrient intakes, and is also taking steps to avoid exposure to chemicals that might impact her pregnancy and the development of her child.

At age 20, she weighed 145 pounds with a BMI of 24.2, still in the healthy zone (18.5-24.9). But like many Americans, she gained about a pound per year in her 20s, a pace of weight gain many experts regard as "normal."

Jane Doe does not want to continue gaining 10 pounds per decade, a rate that would land her in the obese zone along the BMI continuum sometime in her 50s. And so she studied her typical daily diet, identifying calorie-dense foods delivering relatively few nutrients. Largely because of her planned pregnancy, she also decided to switch to mostly organic brands of fresh fruits, vegetables, juices, and grain-based products, to reduce her daily intake of pesticide residues.

Jane Doe's typical "Before" breakfast consists of two slices of white, enriched bread toast with butter, strawberry jam, milk, coffee, and a coffee creamer. Lunch consists of two pieces of pepperoni pizza, a nonfat, fruit (blueberries) yogurt, and a lemon-lime (or any other) soda.

For dinner, a typical meal includes spaghetti and meatballs with tomato sauce, an iceberg lettuce salad with tomato, cucumber and French dressing, and half of a slice of apple pie.

This daily "Before" menu provides Jane with 2,210 calories, about 10 calories per day above her energy needs, placing her on course to gain about 10 pounds over the next decade. She consumes only 3.6 servings of fruits and vegetables, far less than the eight to 13 servings recommended by the government.

Jane Doe's representative "After" breakfast includes organic whole wheat bread, peanut butter instead of butter, and fresh organic strawberries instead of strawberry jam. She also added a six-ounce serving of orange juice.

An organic kiwi is consumed as a mid-morning snack.

Her typical "After" lunch includes plain, low-fat yogurt with a serving of fresh organic blueberries (instead of no-fat fruit yogurt) and a six-ounce can of organic tomato juice, instead of a 12-ounce lemon-lime soda.

Her "After" dinner includes organic, 50% whole-wheat spaghetti instead of enriched. One-half cup of organic sweet bell peppers is added to the now organic tomato sauce, and her salad ingredients are organic. She has an organic apple for desert, instead of apple pie. Her "After" diet delivers 2,200 calories, and should prevent any further weight gain. She consumes 12 daily servings of fruits and vegetables, at the high end of the recommended eight to 13 servings.

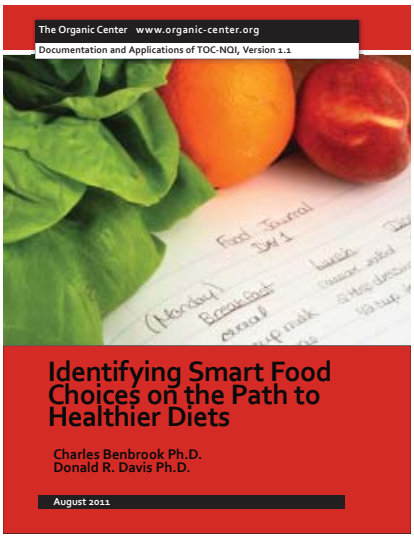
Details on portion sizes and nutritional contributions of each of the items in Jane Doe's "Before" and "After" diets are presented in section III, while IV covers pesticide-related changes.

Dual Benefits of Smart Food Choices

In these examples of Jane Doe's "Before" and After" diets, there were 17 daily foods "Before" and 21 "After." Her smarter food choices entailed switching eight foods for comparable, but healthier, alternatives and adding four new fruit and vegetable items. Over half of the 17 items in her "Before" diet were unchanged.

The collective impacts of Jane Doe's smarter food choices are dramatic. Her daily intake of fruits and vegetables rises from 3.6 to 12.3 servings. Slightly reduced calories should prevent future weight gain as long as she maintains her activity level. Fruits and vegetables account for 57% of the plate weight in her "After" diet, up from 39% and well above the new USDA recommendation that fruits and vegetables account for at least 50% of "MyPlate."

The Organic Center has developed a "Nutritional Quality Index" (TOC-NQI) that quantifies the nutrients provided in a given amount of food (a serving, 100 calories, or 100 grams) (see section III and Benbrook and Davis, 2011 for details). This nutrient profiling system encompasses 27 important nutrients and is based on the degree to which a given food meets the applicable "Recommended Dietary Allowances" (RDAs) across the 27 nutrients. We applied the TOC-NQI to Jane Doe's "Before" and "After" diets to quantify the degree of nutritional improvement. To our knowledge, this is the first-ever application of a nutrient profiling system to all the foods in a person's daily diet.



Her "Before" diet delivers less-than-recommended quantities of 12 of the 27 nutrients. In the case of four nutrients, her daily intakes are less than one-half her RDA, and for antioxidant activity and vitamin D, her intakes were less than one-quarter of her RDAs. If sustained, this degree of deficiency in nutrient intakes will almost certainly lead to adverse health consequences.

In Jane Doe's "After" diet, only seven nutrients are present at levels below the applicable RDAs, and just one at a level less than 50% of the RDA—vitamin D. Moreover, nine nutrients are present at two-fold or more the applicable RDA.

The TOC-NQI value for Jane Doe's "Before" diet is an unsatisfactory 0.85. The top three nutrients contributing to this value are protein, lycopene, and fiber. This level clearly leaves much room for improvement, since a person's daily diet should have a TOC-NQI score of at least 1.5. (A score of one would be sufficient if all of the 27 nutrients were present at exactly the RDA level in a person's diet, no more, no less. But some nutrients will always be present at higher-than-RDA levels, hence the reason why TOC-NQI values should be at least 1.5 for a daily diet).

Her "After" diet TOC-NQI value rises to 1.52, a 79% increase. Her decision to improve food choices, taken by itself (not counting the switch to organic brands), increased the "After" diet's TOC-NQI to 1.43, or by 68%. Choosing organic brands with higher nutrient levels accounted for another 11% increase in the "After" diet's total TOC-NQI, compared to the level in the "Before" diet.

These substantial increases in overall nutritional quality will markedly reduce the odds that dietary deficiencies or excesses will emerge as a major cause of health problems as Jane Doe ages. Her markedly improved levels of nutrient intakes will help set the stage for a healthy pregnancy and should enhance her immune system's ability to deal with the pathogens that everyone encounters on a daily basis.

Her smart food choices also reduce pesticide dietary risks. On an average day, Jane Doe's "Before" diet will expose her to 17 pesticide residues in her food and beverages (not counting drinking water), based on the most recent results reported by the USDA's "Pesticide Data Program" (PDP). Together, these 17 residues pose aggregate dietary risks in her "Before" diet of 2.0, based on the Center's "Dietary Risk Index" (DRI).

Our DRI quantifies pesticide dietary risks based on the frequency of residues, average residue levels, and pesticide toxicity. It draws upon widely accepted Environmental Protection Agency risk assessment science policies and is consistent with the methods suggested by produce industry organizations (see section IV for details).

Jane Doe's "After" diet includes 12 organic foods or ingredient choices, targeted toward those foods that typically contain multiple residues. The number of residues in her daily diet drops as a result from 17 to 5, and the DRI value across all foods in her "After" diet drops by over two-thirds to 0.62, from the "Before" diet's level of 2.0.

This reduction comes despite Jane Doe's more than tripling her servings of fruits and vegetables, the major sources of pesticide risk in American diets. The 3.6 servings of fruits and vegetables in Jane's "Before" diet accounts for a total DRI score of 1.58, or an average of 0.44 per serving. Her "After" diet contains 12.3 servings of fruits and vegetables, with a total DRI score of 0.45, or only 0.036 per serving. The switch to mostly organic fruits and vegetables reduced Jane Doe's pesticide risks per serving by 12-fold.

Hope in Sight

Over 150 million Americans struggle to cut back on excessive caloric intake and make healthier, safer food choices. Despite nearly unlimited choices, nutrient deficiencies and escesses persist in American diets, opening the door to chronic, degenerative diseases like diabetes, cancer, and heart disease. Meanwhile pesticide residues and risk remain all-too-common, especially in imported, conventional fruits and vegetables.

Our analysis shows that smart food choices can markedly enhance likely long-run health trajectories, both for the current generation and the next. Our hope is that as people come to understand the power of small steps, more will be taken and the path toward healthier diets will become clearer and easier to navigate.

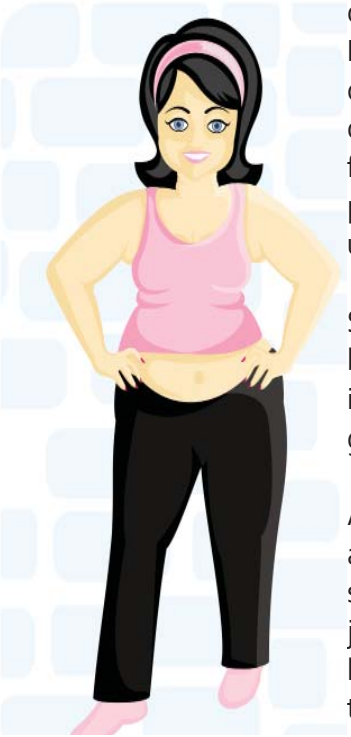
2. MEET JANE DOE

Jane Doe is a 30-year old woman in good health. She is 5' 5" tall and weighs 155 pounds, resulting in a Body Mass Index (BMI) of 25.8, just into the overweight range of BMIs (25 through 29.9).

At age 20, her weight was 145 pounds and her BMI of 24.2 was still in the healthy zone (18.5-24.9). But on the average day over the past decade, Jane Doe stored about 10 extra calories per day in the form of body fat, resulting in about one pound of weight gain per year. On average, American adults gain 0.8 pounds per year throughout adulthood, and hence such a rate of gain is often referred to as "normal" (Mozaffarian, D. et al., 2011).

The 10 extra calories stored each day by Jane Doe as fat during her 20s represent less than one-half of 1% of her average, daily 2,200 caloric intake, a very slim over-eating margin. The 10 extra calories could have come from one or two bites of most foods, one French fry, or a fraction of a glass of chardonnay.

It is often reported, but never literally true that one extra calorie in a person's daily diet equals one calorie's worth of weight gain, all other things being equal. Changes in food intake trigger changes in metabolism, which in turn can change the rate at which calories are burned. Activity levels vary and sleep patterns can deviate, impacting how many



calories are burned at night. Digestive systems work more or less efficiently some days, compared to others, and so fewer or more calories may pass through the GI tract unabsorbed on any given day.

Still, the fundamental linkage between too many calories in a person's diet and weight gain remains a fact of life.

Alternatively, Jane could burn an extra 10 calories worth of stored fat per day by adding just a little more exercise to her daily routines—walking the dog or climbing stairs for a few extra minutes, or riding an exercise bike during a small part of the nightly news. Consuming extra calories sufficient to store 10 calories worth of new body fat per day, or cutting calories sufficient to burn 10 calories worth of fat per day, will have dramatically different impacts on body weight over Jane Doe's adult life, as portrayed graphically in Figure 1.

THE BODY MASS INDEX (BMI)

BMI IS A WIDELY USED MEASURE OF A PERSON'S WEIGHT RELATIVE TO WHAT IS REGARDED AS A HEALTHY WEIGHT FOR A PERSON OF A GIVEN SEX AND HEIGHT.

BMI VALUES BETWEEN 18.5 AND 24.9 ARE REGARDED AS IN THE HEALTHY RANGE. BMIs BETWEEN 25 AND 29.9 FALL IN THE "OVERWEIGHT" RANGE, AND THE OBESE ZONE BEGINS WITH A BMI OF 30.

ACCESS AN EASY-TO-USE BMI CALCULATOR ON THE AARP WEBSITE:
http://www.aarp.org/health/fitness/info-05-2010/bmi_calculator.html

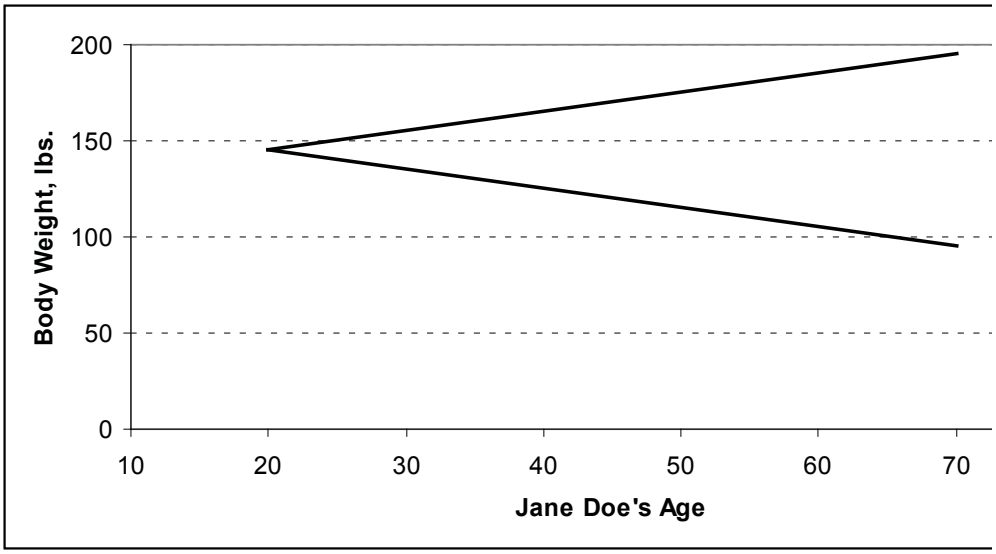


Figure 1. Jane Doe's Body Weight if She Stores or Burns Ten Calories Worth of Body Fat per Day

In her 20s, Jane Doe didn't pay close enough attention to her weight and diet and incrementally picked up 10 pounds. Today, she is determined to not weigh 165 pounds on her 40th birthday, a weight that would place her at the cusp of the obese zone.

In addition, her doctor advised Jane Doe to pay closer attention to nutrient intakes, especially during her hoped for, upcoming pregnancy. In response, Jane spent time on the USDA's "MyPlate" website (http://www.choosemyplate.gov/) and was surprised to learn the degree to which her diet differed from the diet recommended by the government and thought to optimize health outcomes.

Jane Doe also has been paying attention to media coverage on new studies linking chemical exposures, including pesticides, to birth defects (Christiansen, S. et al., 2009; Whyatt et al., 2004), cognitive deficits (Engel, S.M. et al., 2011; Chevier, J. et al., 2011; Rauh, V. et al., 2011), ADHD (Bouchard, M. et al., 2010; Marks et al., 2010), asthma (Hernandez, A.F. et al., 2011), and diabetes (Patel, C. et al., 2010; Lim, S. et al., 2009). She worries that the government may not have taken all the steps needed to avoid risks to infants and children, and so has decided to take additional steps to reduce her own, and her family's exposures to pesticides, as recommended in the 2009-2010 President's Cancer Panel report (National Cancer Institute, 2010).

She has tested her drinking water and installed a state-of-the-art filter system. To reduce pesticide exposures via food, she has switched from conventional to organic brands for the fruits and vegetables known to frequently contain multiple pesticide residues (Lu, C. et al., 2008). Buying organic fresh produce was a priority because she was also determined to increase her daily servings of fruits and vegetables to boost her daily intakes of essential nutrients.

And so, Jane Doe decided to change her daily food choices, creating what we refer to as Jane Doe's "Before" and "After" daily diets.

II. Changes in Jane Doe's Diet

Jane Doe's "Before" breakfast, lunch, and dinner provides 2,210 calories, about 9.6 calories per day above her energy needs, placing her on course to gain about 10 pounds over the next decade if this many calories per day are stored in her body as new fat (Hall, K. D. et al., 2011).

Her "Before" breakfast consists of two slices of toast made from white, enriched bread with butter, strawberry jam, milk, coffee, and a coffee creamer.

Lunch consists of two pieces of pepperoni pizza, a nonfat, fruit yogurt, and a lemon-lime (or any other) soda.

For dinner, she eats spaghetti and meatballs with tomato sauce, an iceberg lettuce salad with tomato, cucumber and French dressing, and one-half of a slice of apple pie.

Portion sizes, calories, and other details on Jane Doe's "Before" daily diet are presented in Table 1. This representative daily menu provides Jane with only 3.6 servings of fruits and vegetables, about average for adult women but far less than the eight to 13 servings recommended by the government.

In the recently released "MyPlate" dietary guidelines, the USDA recommends that one-half of the plate representing food consumed in a day is covered with fruits and vegetables. In terms of total weight, Jane Doe's "Before" daily diet consists of 1,130 grams of food (2.5 pounds), of which 360 grams (about 3/4 pound) are fruits and vegetables. Accordingly by weight, 32% of Jane Doe's daily diet is composed of fruits and vegetables, well short of the new USDA recommendation of 50%.

Table 1. Jane Doe's "Before" Daily Diet

Food	Amount	Calories	% of Calories	Fruit and Vegetable Servings
Breakfast				
BREAD, white enriched	2 slices	133	6	
BUTTER	2 pats	72	3	
JAM, strawberry	2 Tbsp	109	5	0.06
MILK, nonfat, with vitamins A & D	8 fl.oz	84	4	
COFFEE, brewed	8 fl.oz	2	0	
COFFEE CREAMER, dry	1 tsp	11	1	
Lunch				
PEPPERONI PIZZA	2 slices	537	24	
YOGURT, fruit, nonfat	8 oz	215	10	0.13
LEMON-LIME SODA	12 fl.oz	148	7	
Dinner				
SPAGHETTI, enriched, cooked	1.1 cup	243	11	
SPAGHETTI SAUCE	0.5 cup	112	5	1.00
BEEF, ground, cooked	3 oz	230	10	
LETTUCE, iceberg	1 cup	8	0	1.00
TOMATO, raw	0.5 each	11	1	0.75
CUCUMBER, peeled, raw	0.25 cup	4	0	0.50
SALAD DRESSING, French	2 Tbsp	143	6	
PIE, apple	0.5 slice	148	7	0.13
TOTALS		2210	100	3.6

Jane Doe's "After" Diet

To eat healthier and reduce pesticide residues, Jane Doe's "After" diet is composed of more fruits and vegetables, six ounce servings of orange and tomato juice instead of 12-ounces of full-sugar soda, and mostly organic fruits, vegetables, and grains, as opposed to conventional.

Instead of enriched white bread for breakfast, she switched to whole wheat bread, and to cut calories from added fat, she dropped the butter in favor of the more nutritious peanut butter. To further increase nutrient intakes, she switched from strawberry jam to organic strawberries.

Jane Doe added an organic kiwi as a mid-morning snack.

She made two changes in her typical lunch. Instead of an eight-ounce serving of sweetened, nonfat blueberry fruit yogurt, she now consumes eight ounces of low-fat, plain yogurt, with one-half cup of organic, fresh blueberries. This switch adds significant nutrients and cuts 30 calories. She also replaced the full-sugar soda with a six-ounce can of organic tomato juice, adding nutrients and cutting another 117 calories from her luncheon menu.

In her typical dinner meal, Jane Doe now substitutes 50% whole-wheat spaghetti for the enriched, white spaghetti in her "Before" diet and adds one-half cup of sweet bell peppers to the tomato sauce. She enjoys an apple, instead of apple pie for desert.

Details of Jane Doe's "After" daily diet appear in Table 2, on page 8. It delivers 2,200 calories, her estimated daily energy needs, thus setting the stage for no weight gain. Her "After" diet delivers an impressive 12.3 servings of fruits and vegetables, which now account for 57% of her overall plate weight—7% higher than the new USDA recommendation that fruits and vegetables account for at least 50% of the "plate."

Jane Doe's "After" diet essentially eliminates the risk of weight gain and incremental progress along the BMI continuum. She goes from a significant deficiency in fruit and vegetable intake, to the upper-end in the recommended range of 8 to 13 daily servings. She exceeds the USDA goal of assuring that fruits and vegetables account for at least one-half her plate.

Table 2. Jane Doe "After" Daily Diet

Food	Amount	Calories	% of Calories	Fruit and Vegetable Servings
Breakfast				
BREAD, whole wheat	2 slices	133	6	
PEANUT BUTTER	2 Tbsp	190	9	
STRAWBERRY, raw	0.5 cup	24	1	1.00
MILK, nonfat, with vitamins A & D	8 fl.oz	84	4	
COFFEE, brewed	8 fl.oz	2	0	
CREAM, light	1 Tbsp	29	1	
ORANGE JUICE, fresh	6 fl.oz	84	4	1.50
Snack				
KIWI, peeled, raw	1 fruit	42	2	1.00
Lunch				
PEPPERONI PIZZA	2 slices	537	24	
YOGURT, plain, low fat	8 oz	143	6	
BLUEBERRIES, raw	0.5 cup	42	2	1.00
TOMATO JUICE, canned	6 fl.oz	31	1	1.50
Dinner				
SPAGHETTI, 50% whole wheat, cooked	1.3 cup	259	12	
SPAGHETTI SAUCE	0.5 cup	112	5	1.00
BELL PEPPER, green, raw	0.5 cup	15	1	1.00
BEEF, ground, cooked	3 oz	230	10	
LETTUCE, iceberg	1 cup	8	0	1.00
TOMATO, raw	0.5 each	11	1	0.75
CUCUMBER, peeled, raw	0.25 cup	4	0	0.50
SALAD DRESSING, French	2 Tbsp	143	7	
APPLE, Red Delicious, unpeeled	1 fruit	77	4	2.00
TOTALS		2200	100	12.3

Switch to Organic Brands

In hopes of reducing her exposures to pesticides, Jane Doe's "After" diet includes organic brands of the following fruits and vegetables—strawberries, kiwi, blueberries, tomato products, sweet bell pepper, lettuce, cucumber, and apple. She also selected organic bread and spaghetti.

Choosing organic brands for these foods will also increase some of her nutrient intakes, because organic fruits, vegetables, and grains are, on average, more nutrient dense than their conventional counterparts, as documented in the Center's 2008 report "New Evidence Confirms the Nutritional Superiority of Plant-Based Organic Foods" (Benbrook et al., 2008).

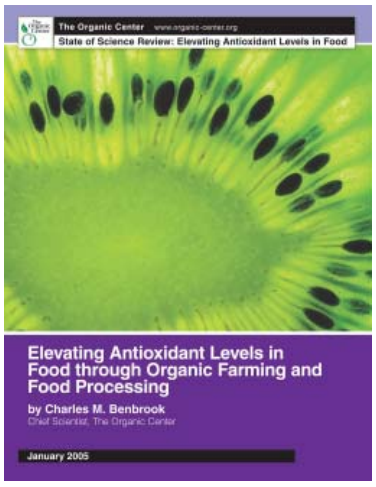
In section III we quantify the nutritional benefits stemming from these changes in Jane Doe's diet and Appendix Table 1 provides details on how nutrient levels were adjusted in the organic foods in Jane's "After" diet. In IV, we project the likely reduction in her exposure to pesticides and pesticide risk.

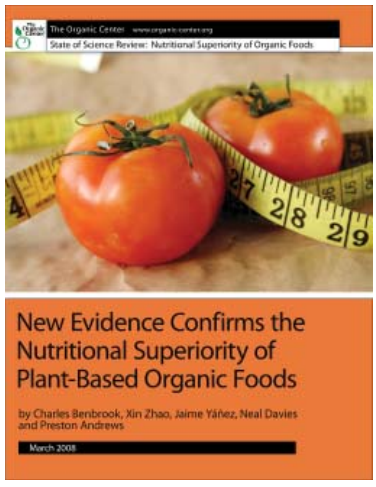
This is the first time that both the nutritional quality and pesticide risk reduction benefits of a set of changes in daily food choices have been rigorously quantified drawing on contemporary USDA data and widely accepted risk assessment methods.

3. THE NUTRITIONAL QUALITY OF JANE DOE'S "BEFORE" AND "AFTER" DIETS

While many mysteries remain in deciphering the nutritional quality of food, much is known about the ingredients a person must get through their diet to sustain good health. These include both the "essential" nutrients for which the government has set "Recommended Dietary Allowances" (RDAs), or other acceptable daily intakes, and several phytochemicals that are important in health promotion in ways not fully understood.

Some of these phytochemicals may not prove to be "essential," since many of them appear to have similar benefits, making no single one "essential." Examples of clearly important phytochemicals include lycopene, lutein, and many plant polyphenols with potent antioxidant activity.





Organic farming systems consistently increase the levels of health-promoting antioxidants, as documented in previous TOC reports.

Drawing on government-set RDAs for essential nutrients, as well as estimates of desirable intakes of other known constituents in food, The Organic Center has developed a "Nutritional Quality Index" (TOC-NQI) that can be applied to quantify the nutritional quality of single foods, multi-ingredient foods, meals, and daily diets. (For details on the methodology, the data sources and equations used in the TOC-NQI, see the report *Identifying Smart Food Choices on the Path To Healthier Diets*, accessible at http://www.organic-center.org/TOC-NQI).

The TOC-NQI encompasses the 27 nutrients and phytochemicals shown below. Initial weights are assigned to each item or group as follows:

- Eleven vitamins – 26.4% (2.4% each)
- Eight minerals – 19.2% (2.4% each)
- Protein – 16%
- Fiber – 10%
- Antioxidant activity as measured by total ORAC – 8%
- Lutein + zeaxanthin – 5%
- Linoleic acid – 5%
- Linolenic acid – 5%
- Lycopene – 3%
- Choline – 2.4%

The 11 vitamins include A, D, E, K, B_6, B12, C, folate, thiamin (B1), riboflavin (B2), and niacin (B_3). Each is assigned an initial weight of 2.4%.

The eight minerals, also with an initial weight of 2.4%, include calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P), copper (Cu), iron (Fe), selenium (Se), and zinc (Zn).

These initial weights are then adjusted based on the degree to which an average diet consumed by a population is adequate or deficient in each nutrient. The greater the deficiency, the higher the weight placed on that nutrient's contents in a given food. (For details on this weighting method, and the data sources and equations used in the TOC-NQI (see *Identifying Smart Food Choices on the Path To Healthier Diets).*

The TOC-NQI contribution for a given nutrient in, for example, an apple, is the amount of the nutrient in a serving

of apple (or 100 calories of apple, or 100 grams of apple), relative to the government's RDA for that nutrient. This ratio for each nutrient is then multiplied by the weight assigned to the nutrient. These values are then added together across the 27 nutrients, producing an aggregate food TOC-NQI.

We calculated the nutritional quality of Jane Doe's daily "Before" and "After" diets using the TOC-NQI, based on the assumption that Jane Doe's average daily diet over an extended time period includes the same average nutrient intakes as other U.S. women in Jane Doe's age cohort. This assumption may not accurately reflect the degree of adequacy/inadequacy for specific nutrients in Jane's daily diet, and hence the relative weights we assign to various nutrients might be slightly skewed as a result.

Improvements in Jane Doe's diet are brought about largely because of changes in food choices, for example, substituting tomato juice for a Lemon-Lime soda during lunch. The partial switch to organic fruits, vegetables and grains also improved her diet's overall NQI value by about 11%, as shown below. The TOC-NQI is designed to allow adjustments in the nutrient levels of foods as a function of many factors including production system (conventional versus organic), crop genetics, food form (fresh, dried, canned, or frozen), and cooking method (boiled, fried, baked).

In quantifying the TOC-NQI impact of choosing organic fruits, vegetables, and grains in the "After" diet, we identified well-documented differences in the levels of some nutrients in conventional versus organic samples of the same food, grown in the same area, using the same plant genetics (so-called "matched pair" studies). For the organic foods in Jane Doe's "After" diet (except lettuce), nutrient content data were available from high quality, peer-reviewed publications (see the Appendix Table 1 for details). We established adjustment factors for 71 food-nutrient combinations out of a possible 243 (29%). Values were higher in the organic foods in 34 cases (mostly ORAC and vitamins C and E), and lower in 31 cases (mostly protein and vitamin A).

Because of the limited scope of high-quality studies comparing the nutrient content of organic and conventionally grown foods, it is likely that our results marginally underestimate the full nutritional benefits of the organic foods in Jane Doe's "After" diet. In addition, we did not strive to adjust any nutrients in meats, milk or dairy products.

Individual Nutrient Intakes

Jane Doe's "Before" diet delivers less-than-recommended quantities of 12 of the 27 nutrients. In the case of four nutrients—total antioxidant intake as measured by ORAC, lutein + zeaxanthin, vitamin C, and vitamin D—her daily intakes are less than half her RDA or estimated RDA, and for ORAC and vitamin D, her intakes were less than one-quarter of recommendations.

Three nutrients are present in the "Before" diet at levels twice or more the RDA — vitamin B12, selenium, and riboflavin.

The impact of Jane Doe's "After" diet on nutrient levels is dramatic for many nutrients. Only seven nutrients are present at levels below the RDA, and just one at a level less than one-half of the RDA—vitamin D, which is also supplied by adequate exposure of skin to sunlight. Moreover, nine nutrients are present at two-fold or more of the applicable RDA, triple the number in the "Before" diet.

Figures 2 and 3 display these findings graphically and array the levels of intake of the 27 nutrients in the "Before" and "After" diets relative to Jane Doe's RDA or estimated RDA for each nutrient .

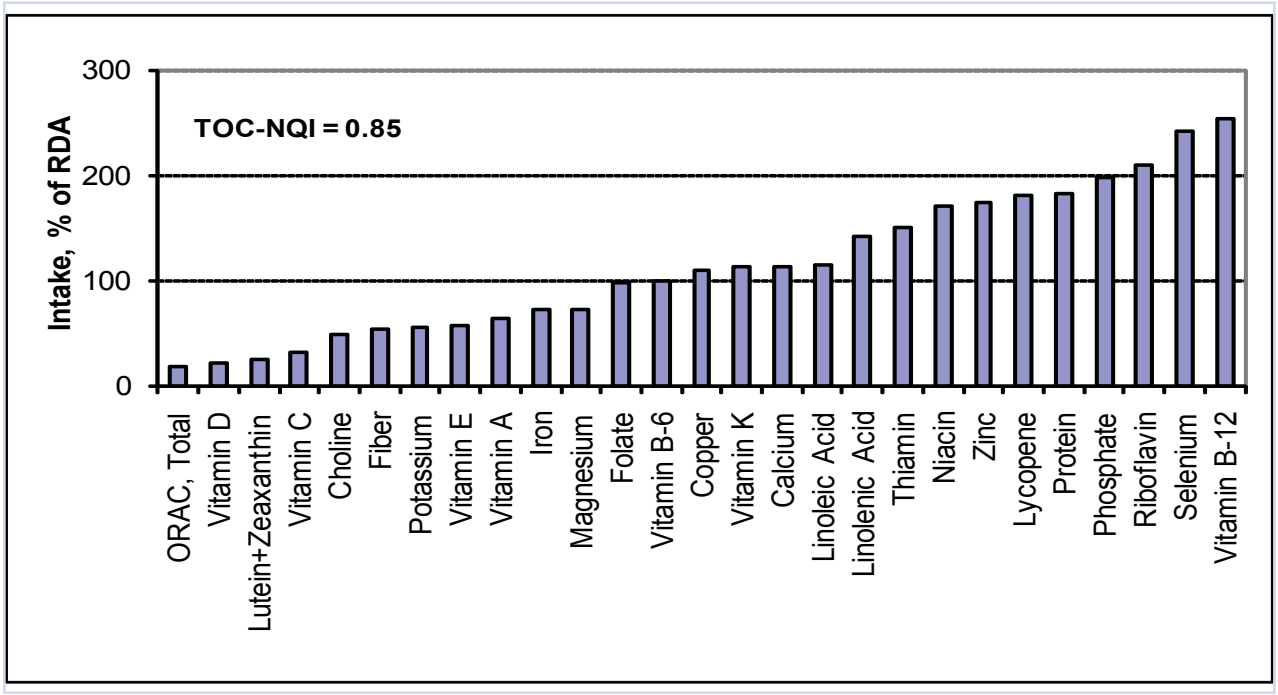


Figure 2. Nutrients Levels in Jane Doe's "Before" Diet Compared to Applicable RDAs

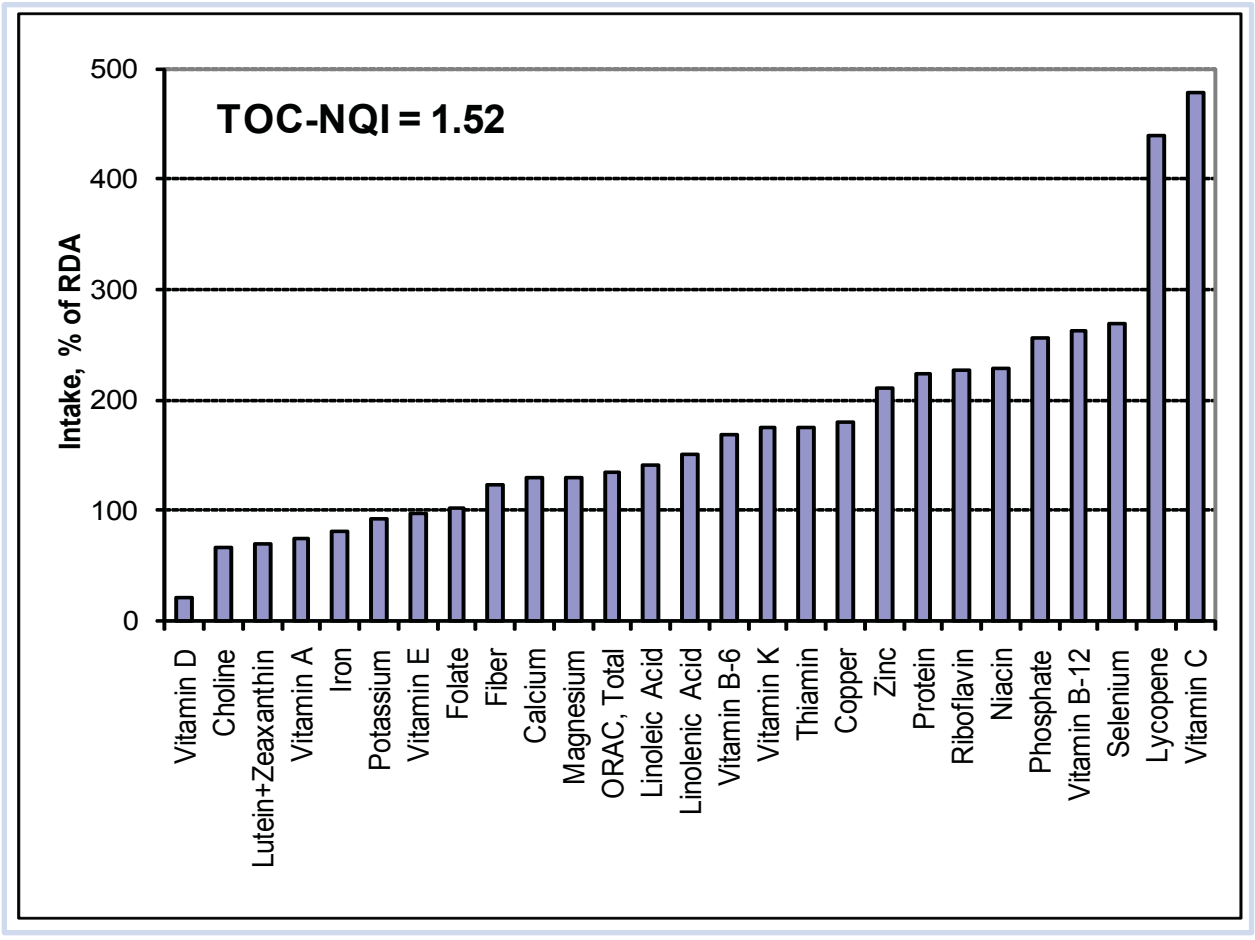


Figure 3. Nutrients Levels in Jane Doe's "After" Diet Compared to Applicable RDAs

Overall Nutritional Quality

Taking into account all the foods and beverages in Jane Doe's "Before" daily diet, its TOC-NQI value is 0.85. The top three nutrients contributing to this value are protein, lycopene, and fiber. This level clearly leaves considerable room for improvement. As noted above, this diet delivers less-than-recommended levels of 12 nutrients.

If each of the 27 nutrients were present in Jane Doe's diet at exactly her RDA level, no more or no less, the TOC-NQI value for her whole diet would be one. But no diet in the real world will ever be so precise. Accordingly, TOC-NQI values consistent with a diet that delivers most nutrients in recommended quantities, and some in excess, should fall in the range 1.5 to 2.0.

For people that include considerable diversity in their dietary choices from day to day and ample servings of nutrient-dense foods, it is probable that deficiencies in certain nutrients will not re-occur over several days in a week or a month. In such a case, a TOC-NQI value of around 1.5 is probably a sound target in meal planning. But for people with limited diversity in food choices, a value of 2, or even higher, should be considered, coupled with special focus on chronically under-consumed nutrients.

Jane Doe took two important steps to improve the quality of her daily diet. She dropped some less nutritious foods and condiments that deliver mostly empty calories (a.k.a. junk food), replacing them with more nutrient-rich fruits, vegetables, or whole grain products. Plus, she fit eight more servings of fruits and vegetables into her daily diet, while actually lowering caloric intake by 10 calories, mostly by avoiding some high-added-sugar foods.

She also switched to mostly organic fruits and vegetables, marginally increasing her intake of some nutrients, especially vitamin C and total antioxidant activity as measured by the Oxygen Radical Absorbance Capacity (ORAC) assay (ORAC, 2010).

These wiser food choices in Jane Doe's "After" diet increased her TOC-NQI value to 1.52, from 0.85, a 79% increase. Her decision to make smarter food choices, taken by itself (not counting the switch to organic brands), increased the "After" diet's TOC-NQI to 1.43, or by 68%. Choosing organic brands accounted for another 11% increase in the "After" diet's total TOC-NQI, compared to the level in the "Before" diet.

FOOD CHOICES CAN DRAMATICALLY REDUCE THE ODDS THAT NUTRIENT DEFICIENCIES—OR EXCESSES—WILL CONTRIBUTE SIGNIFICANTLY TO LONG-TERM HEALTH PROBLEMS.

This substantial increase in overall dietary nutritional quality should be sufficient to markedly reduce the odds that dietary excesses and nutrient inadequacies will be a dominant cause of health problems as Jane Doe ages. Unfortunately there will likely be other, unanticipated events in Jane Doe's life that might threaten her health, but by sticking to the "After" diet, she will largely eliminate one cluster of risk factors that might otherwise play a negative role in her long-term health trajectory.

4. GROWING HEALTHY BABIES

Jane Doe is determined to reduce her, and her family's, exposure to pesticides, while also increasing their daily servings of fresh fruits and vegetables. For this reason, she has decided to seek out organic brands for those foods in her daily diet known to often contain one or more pesticide residues. In Jane Doe's "After" diet, 12 out of 21 foods are organic or contain primary ingredients that are organic.

Most of the fresh produce and fruit-vegetable juices she purchases are organic, as is the flour in her whole wheat bread, and whole-wheat spaghetti, and the tomato sauce with her spaghetti at dinner. These 12 organic items were chosen because Jane knew that fruits and vegetables contain markedly more pesticide residues than other categories of food.

Table 3 provides an overview of the pesticide exposures in Jane Doe's "Before" daily diet. The food-specific data in the table are from the USDA's "Pesticide Data Program" (see Appendix Table 2 for details). The actual number of residues in any given food in Jane Doe's diet could be lower or higher than the average reported by PDP, but over a full year, these estimates are reasonably accurate.

There is greater uncertainty in estimating the number of residues in the grain-based products in Jane Doe's diet, because the PDP has not tested wheat flour since 2005, and has never tested baked products like bread. For this reason, we reduced by one-half the expected, average number of residues and risk in the bread and spaghetti in the "Before" diet.

Since cooking and processing typically removes a significant share of the residues from the raw fruits and vegetables tested by the PDP, we reduced by one-half the number of residues expected in strawberry jam, relative to the number of residues found in strawberries. Risks linked to strawberry jam were also reduced 50% relative to the risk in fresh strawberries, the food form for which PDP results were available from testing in 2009. The same adjustment was made for several other processed food forms in the "Before" diet (see Table 3 footnotes).

In the case of the Pepperoni pizza for lunch, we include residues expected in the pizza crust, as well as residues in the pork used to make the pepperoni. As is evident in the table, there are far fewer pesticide residues in meat and processed meat products than in fruits and vegetables.

Estimating Dietary Risk Levels

The number of residues in a food, or in a person's daily diet, is actually a poor proxy for pesticide dietary risk. Why? Because pesticide risk in a serving of food is driven both by pesticide toxicity and the level at which residues are present. The frequency of residues in a given food (i.e., the percent of tested samples that show a quantifiable residue) drives how many exposure incidents there are in a given day; the pesticide's toxicity, coupled with average residue levels, determines how risky a given exposure occurrence is likely to be.

Some foods might contain only one or a few residues, but relatively high levels of a moderate to highly toxic chemical, whereas other foods might have five residues on average, but none that pose worrisome risks, at least not based on current toxicological knowledge.

The Organic Center has developed a "Dietary Risk Index" (DRI, see the box on next page) that quantifies levels of risk in a given serving of food, based on the latest pesticide toxicology data from the U.S. Environmental Protection Agency (EPA).

USDA reports pesticide levels in both U.S. and imported samples, allowing separate estimates to be made of

Measuring Pesticide Dietary Risks

Reliable methods and extensive, high-quality government data exist to track pesticide risk levels in foods and beverages. The Center uses a "Dietary Risk Index," or DRI, to calculate pesticide risk levels from residues in a serving of a specific food.

The DRI is based on EPA risk assessment methods and relies solely on USDA pesticide residue data. For each pesticide found in a given food, the DRI for that food-pesticide combination is a measure of how close the average level of residues found in the food is to the maximum amount of the pesticide believed to be acceptable by the EPA.

Aggregate DRI values for a food are calculated by adding up the pesticide-food specific DRIs across all pesticides found in a food in a given year. This step assumes that risk levels in a given food are additive across pesticides present in the food. This is not always true, e.g., some pesticides can act synergistically, heightening risks.

TOC's aggregate DRIs are only as complete and accurate as today's risk assessment methods and data on pesticide toxicity and residue levels.

pesticide risk levels in domestic versus imported foods. USDA also reports residues in samples labeled as "organic," making it possible to compare DRI levels in organic versus conventionally grown foods. Based on extensive Organic Center analyses of residues in conventional and organic foods, organic farming typically reduces risk levels by at least 90%, and often 100% (Benbrook, 2008).

In general, aggregate DRI values for a food that are less than 0.1 raise minimal risk concerns, while DRI values between 0.1 and 0.9 warrant attention, and possibly, efforts to reduce exposures. Values of 1.0 or higher may point to unacceptable risks relative to the EPA's basic pesticide residue safety standard . For most foods, residues of just one or two pesticides account for three-quarters or more of aggregate DRI risk in any given year, and in many cases, a single pesticide accounts for 95% or more.

For example, in imported asparagus, PDP testing in 2009 found residues of the insecticides chlorpyrifos and methamidophos. They accounted for 76% and 24% respectively, and 100% together, of the aggregate DRI value of 0.6 for all pesticides found in imported asparagus. Domestically grown asparagus was much cleaner, with an aggregate DRI of just 0.007, 86-times lower than the value in imported asparagus.

Pesticide Risks in Jane Doe's Diet

We used the DRI and USDA pesticide residue data to calculate pesticide risk levels in Jane Doe's "Before" and "After" diets. Table 3 covers the residues and risk in her "Before" diet. Appendix Table 2 provides details on the information used to construct Table 3.

Jane Doe's "Before" diet can be expected to expose her to an average 17 pesticide residues per day, which will include parent active ingredients and some pesticide metabolites and isomers.

The approximate 17 pesticide residues in Jane Doe's "Before" diet pose aggregate risks across all foods in her daily diet of 2.0. The blueberry in the nonfat fruit yogurt at lunch, her strawberry jam for breakfast, and the tomato and cucumber in her dinner salad account for the largest shares of risk. (Table 3 does not include residues and risk from pesticides in Jane Doe's drinking water. Depending on where Jane Doe lives, drinking water might add significantly, or next to nothing, to her daily pesticide exposures and risk).

Table 3. Pesticide Residues and Risk in Jane Doe's "Before" Daily Diet ("ND" = No Residue Data; "DRI" = Dietary Risk Index)

Food		Most Recent Residue Data	Average No. of Residues	DRI	% of DRI Total
Breakfast					
BREAD, white enriched	2 slices	2004	0.4*	0.14*	7.0%
BUTTER	2 pats	2003	1.5	0.002	0.1%
JAM, strawberry	2 Tbsp	2009	2.9*	0.24*	12.0%
MILK, nonfat, with vitamins A & D	8 fl.oz	2005	0.7	0.0005	0.02%
COFFEE, brewed	8 fl.oz		ND	ND	
COFFEE CREAMER, dry	1 tsp		ND	ND	
Lunch					
Pork in PEPPERONI PIZZA	2 slices	2005	0.03*	0	0.0%
Wheat flour in PEPPERONI PIZZA	2 slices	2004	0.4*	0.14*	7.0%
Fruit in YOGURT, fruit, nonfat, blueberry	8 Oz	2009	1.33*	0.74*	37.0%
LEMON-LIME SODA	12 fl.oz		ND	ND	
Dinner					
SPAGHETTI, enriched, cooked	1.1 cup	2004	0.4*	0.14	7.0%
SPAGHETTI SAUCE	0.5 cup	2009	0.04**	0.0093**	0.5%
BEEF, ground, cooked	3 Oz	2009	0.05	0.0003	0.01%
LETTUCE, iceberg	1 cup	2005	3.7	0.1	5.0%
TOMATO, raw	0.5 each	2008	1.2	0.235	11.7%
CUCUMBER, peeled, raw	0.25 cup	2009	3	0.233	11.6%
SALAD DRESSING, French	2 Tbsp		ND	ND	
PIE, apple	0.5 slice	2006	1.7***	0.02***	1.0%
TOTALS			17.4	2.00	100%

* Based on 50% of residues removed in processing/manufacturing, reducing DRI risk by one-half.

** Based on results for tomato paste.

*** Based on one-half the residues and risk in apple sauce.

Sources: Average number of residues by food from the most recent year of testing by USDA's "Pesticide Data program" (PDP), for all samples combined (imports and domestic production). "Dietary Risk Index" (DRI) values from The Organic Center's analysis of PDP residue data, see (Benbrook, 2011) for methodological details.

Table 4. Pesticide Residues and Risk in Jane Doe's "After" Daily Diet ("ND" = No Residue Data; "DRI" = Dietary Risk Index)

Food		Most Recent Residue Data	Average No. of Residues	DRI	% of DRI Total
Breakfast					
Organic BREAD, whole wheat*	2 slices	2004	0.04	0.014	2.27%
PEANUT BUTTER	2 Tbsp	2006	0.3	0.001	0.16%
Organic STRAWBERRY, raw*	0.5 cup	2009	0.577	0.048	7.79%
MILK, nonfat, with vitamins A & D	8 fl.oz	2005	0.7	0.0005	0.08%
COFFEE, brewed	8 fl.oz		ND	ND	
CREAM, light	1 Tbsp		ND	ND	
ORANGE JUICE, fresh	6 fl.oz	2006	0.8	0.04	6.49%
Snack					
Organic KIWI, peeled, raw	1 fruit	Not Tested by PDP	ND	ND	
Lunch					
Pork in PEPPERONI PIZZA	2 slices	2005	0.03	0	0.00%
Wheat Flour in PEPPERONI PIZZA	2 slices	2004	0.4	0.14	22.73%
YOGURT, plain, low fat	8 Oz		ND	ND	
Organic BLUEBERRY, raw*	0.5 cup	2008	0.27	0.015	2.44%
Organic TOMATO JUICE**	6 fl.oz	2009	0.004	0.0009	0.15%
Dinner					
Organic SPAGHETTI, 50% whole wheat	1.3 cup	2004	0.04	0.014	2.27%
Organic SPAGHETTI SAUCE**	0.5 cup	2009	0.004	0.0009	0.15%
Organic BELL PEPPER, green*	0.5 cup	2004	0.43	0.26	42.21%
BEEF, ground, cooked	3 Oz	2009	0.05	0.0003	0.05%
Organic APPLE, Red Delicious, unpeeled*	1 fruit	2009	0.6	0.034	5.52%
TOTALS			4.87	0.62	100.00%

* Based on 90% reduction in frequency of residues and risk in the comparable conventional product. The reduction is brought about by organic management.

** Based on results for tomato paste and 90% reduction in residues/risk in organic.

Sources: Average number of residues by food from the most recent year of testing by USDA's "Pesticide Data program" (PDP), for all samples combined (imports and domestic production). "Dietary Risk Index" (DRI) values from The Organic Center's analysis of PDP residue data, see (Benbrook, 2011) for methodological details.

Table 4 reports the same information for Jane Doe's "After" diet that includes 12 organic food or ingredient choices, as noted in the table. The average number of residues drops from 17 to 5.

We had the residue data necessary to directly calculate conventional versus organic residues and risk levels in the case of one food, lettuce. The DRI for conventional lettuce tested in 2005 was 0.1, whereas the organic lettuce DRI in 2009 was just 0.0013, a 98.7% reduction. For all other organic foods, we assumed an average 90% reduction in residues and risk, compared to similar conventional foods.

The aggregate DRI value across all foods in Jane Doe's "After" diet declines by over two-thirds to 0.62, from the "Before" level of 2.0.

This two-thirds reduction comes despite Jane Doe's more than tripling her servings of fruit and vegetable products, the major sources of pesticide risk in American diets. The 3.6 servings of conventional fruits and vegetable products in her "Before" diet account for, on average, 0.44 DRI units per serving. The 12.3 servings in her "After" diet account for a DRI total of 0.446, or just 0.036 DRI units per serving, 12-times lower than in Jane Doe's "Before" diet.

These reductions are real and will lessen the risk of a variety of possible adverse health outcomes if and when Jane Doe is pregnant. Keeping pesticide exposures and risk as low as possible during pregnancy and throughout the first years of a child's life is the best way to prevent a suite of developmental abnormalities that can increase the child's risk of a host of problems later in life (NRC, 1993; Adigun et al., 2010; Bouchard et al., 2010; Rauh, et al., 2011).

In ways that science has yet to fully understand, it is also likely that the combined nutritional and food safety impacts of the changes in Jane Doe's diet will reinforce healthy patterns of development in her children, and reduce the odds that the family will struggle with food allergies, asthma, ADHD, cognitive problems, reproductive issues, or even cancer, obesity, and diabetes.

Rapid advances are occurring in our understanding of the ways that low-level pesticide exposures during pregnancy can trigger subtle, epigenetic changes with possible, life-long consequences (e.g., see Lim et al., 2009 and Adigun et al., 2010). The clear message from those working at the cutting edge of the toxicological sciences is that prudent steps to reduce exposures are in order, while science tries to more definitively sort out how chemical exposures increase the odds of various health problems with their roots in prenatal development.

5. OUR HOPEFUL MESSAGE

Over 150 million Americans are struggling to cut back on excessive caloric intake and striving to make healthier food choices. Some are making progress but many more are not. It seems that the essential ingredients for overweight, obesity, and diabetes are virtually hardwired into modern lifestyles.

Despite vast dietary choices for most people, nutrient deficiencies and excesses persist in American diets, opening the door to chronic, degenerative diseases such as diabetes, cancer, and heart disease. Too much added sugar, salt, and the wrong kinds of fat create or worsen other diet-health problems. Excesses and inadequacies in nutrient intakes are made worse in some cases by imbalances across nutrients (see box).

Most Americans struggling with weight management understand the basic steps they need to take to balance caloric intake with their body's needs, yet few are acting systematically on this knowledge. As a result, our nation's pubic health is on a slippery slope. This is why the Centers for Disease Control and Prevention has projected that the current generation of young Americans will be the first to not outlive their parents.

A Monumental Challenge

Motivation sufficient to change food choices is too often a missing piece of the puzzle. Conflicting and confusing information about smart food choices is all too common, giving some people false hope and misleading others. But there are also hopeful signs. Many Americans have discovered new reasons and ways to relate to—and enjoy—food. People are more focused on the ingredients in their food, how food is grown and processed, its safety, and the environmental impacts of farming.

Awareness is growing that more disciplined and data-driven food choices can tip the odds toward sustained, good health. Indeed, even relatively modest changes in diets can dramatically alter long-term health outcomes (Paineau, D. et al., 2010). Herein, we drive this point home by quantifying the significant nutritional and food safety benefits stemming from changes in Jane Doe's diet.

Her smarter food choices will also tip the odds in favor of safe passage for her children through infancy and childhood. Our hope is that new tools like the DRI and TOC-NQI will help give people new confidence in their ability to make sound food choices, while also motivating them to stick with the discipline needed to assure both adequate nutrient intakes and no serious excesses.

OUT OF BALANCE AND BAD FOR THE HEART

CONTEMPORARY U.S. DIETS CONTAIN TOO MUCH OF THE HEART-UNHEALTHY OMEGA-6 FATTY ACIDS AND NOT NEARLY ENOUGH HEART-HEALTHY OMEGA-3S. ON AVERAGE, AMERICANS CONSUME ABOUT 10:1 OMEGA-6S COMPARED TO OMEGA-3S, WITH MANY AMERICANS OVER 15:1 AND SOME AS HIGH AS 40:1. AN OMEGA-6 TO OMEGA-3 RATIO OF AROUND 3:1 OPTIMIZES HEART HEALTH.

MANY STUDIES HAVE REPORTED HEART HEALTH AND MULTIPLE OTHER HEALTH BENEFITS FROM FOOD OPTIONS THAT REDUCE OMEGA-6 INTAKES, WHILE RAISING OMEGA-3S IN THE DIET.

APPENDIX. DATA USED TO ADJUST TOC-NQI AND DRI SCORES FOR ORGANIC FOODS

Appendix Table 1. Adjustment Factors for Estimating Organic Food NQI Values, from Baseline USDA Standard Reference Levels

27 Nutrients in NQI	Apple	Straw-berry	Kiwi	Tomato	Tomato Juice	Blue-berry	Bell Peppers	Cucum-bers	Wheat	All Foods	Organic Higher	Organic Lower
Vitamin A	0.92	0.92	0.92	0.92	0.92	0.92	3.47	0.92			1	7
Vitamin D												
Vitamin E	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15			6	
Vitamin K												
Vitamin B-6												
Vitamin B-12												
Vitamin C	1.10	1.10	1.14	1.10	1.10	1.10	1.23	1.10			6	
Folate												
Niacin												
Riboflavin												
Thiamin												
Calcium	1.00	0.75	1.11				0.67		0.96		1	3
Potassium	0.89	0.67	1.21				0.91		0.96		1	4
Magnesium	1.00	1.08	1.27				0.76		0.98		2	2
Phosphate	0.92	0.91	1.13						1.00		1	2
Copper							0.50		0.86			2
Iron							0.80					2
Selenium												
Zinc	1.10	0.88					0.67		1.03		2	2
Choline												
Fiber												
Linoleic Acid												
alpha-Linolenic Acid												
Protein	0.90	0.90	1.24	0.90	0.90	0.90	0.90	0.90	1.03		2	7
Lutein + Zeaxan-thin							1.13				1	
Lycopene					1.57		1.87				2	
ORAC_Total	1.18	1.08	1.27	1.24	1.44	1.50	1.28	1.24	1.10		9	
Nutrients with Adjustment Factors	10	10	9	5	6	5	13	5	8	71		
% Nutrients Ad-justed	37%	37%	33%	19%	22%	19%	48%	19%	30%	29%		

Sources: Average differences for vitamins A, E, C, protein, and ORAC from (Benbrook, et al., 2008), except for cases where high-quality studies were available for specific crops, as noted below.

Apples: (Peck, et al., 2006); Bell peppers: (Perez-Lopez, et al., 2007); Blueberry: (Wang, et al. 2008); Kiwi: (Amodio, et al., 2006); Strawberry: (Reganold, et al., 2010) and (Wang, et al., 2002); Tomatoes: (Barrett, et al., 2007); Wheat: (Mader, et al., 2007).

As expected from numerous reviews and evident in Appendix Table 1, protein and vitamin A levels are consistently higher in conventionally grown foods, while vitamins C and E, and ORAC levels are higher in organic foods.

Pesticide Residue Data and DRI Values

The data in Tables 3 and 4 are from the USDA's "Pesticide Data Program" (PDP). For all foods, the data chosen represents the most recent year the food was tested by the PDP. Results reflect residues in all samples combined, encompassing domestically grown foods and imported foods. In one case, lettuce, PDP has tested both conventional and organic samples of the same food.

Appendix Table 2. Number of Residues and DRI Values per Serving for Foods in Jane Doe's Diet, Most Recent Year with PDP Data

	PDP Year	Number of Residues	DRI
Apple	2009	5.9	0.335
Beef muscle	2009	0.05	0.0003
Blueberry	2008	2.66	0.148
Cucumber	2009	2.95	0.233
Lettuce	2005	3.73	0.097
Organic lettuce	2009	0.21	0.0013
Peanut butter	2006	0.3	0.0011
Pork muscle	2005	0.06	0.00002
Strawberry	2009	5.77	0.48
Sweet bell peppers	2004	4.3	2.61
Tomatoes	2008	1.22	0.235
Tomato paste	2009	0.04	0.0093
Wheat flour	2004	0.83	0.276

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