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“How Diet Affects Fertility”

Every new life starts with two seemingly simple events. First, an active sperm burrows into a perfectly mature egg. Then the resulting fertilized egg nestles into the specially prepared lining of the uterus and begins to grow. The key phrase in that description is "seemingly simple." Dozens of steps influenced by a cascade of carefully timed hormones are needed to make and mature eggs and sperm. Their union is both a mad dash and a complex dance, choreographed by hormones, physiology and environmental cues.

A constellation of other factors can come into play. Many couples delay having a baby until they are financially ready or have established themselves in their professions. Waiting, though, decreases the odds of conceiving and increases the chances of having a miscarriage. Fewer than 10 percent of women in their early 20s have issues with infertility, compared with nearly 30 percent of those in their early 40s. Sexually transmitted diseases such as chlamydia and gonorrhea, which are on the upswing, can cause or contribute to infertility. The linked epidemics of obesity and diabetes sweeping the country have reproductive repercussions. Environmental contaminants known as endocrine disruptors, such as some pesticides and emissions from burning plastics, appear to affect fertility in women and men. Stress and anxiety, both in general and about fertility, can also interfere with getting pregnant. Add all these to the complexity of conception and it's no wonder that infertility is a common problem, besetting an estimated 6 million American couples.

It's almost become a cliché that diet, exercise and lifestyle choices affect how long you'll live, the health of your heart, the odds you'll develop cancer and a host of other health-related issues. Is fertility on this list? The answer to that question has long been a qualified "maybe," based on old wives' tales, conventional wisdom—and almost no science. Farmers, ranchers and animal scientists know more about how nutrition affects fertility in cows, pigs and other commercially important animals than fertility experts know about how it affects reproduction in humans. There are small hints scattered across medical journals, but few systematic studies of this crucial connection in people.

We set out to change this critical information gap with the help of more than 18,000 women taking part in the Nurses' Health Study, a long-term research project looking at the effects of diet and other factors on the development of chronic conditions such as heart disease, cancer and other diseases. Each of these women said she was trying to have a baby. Over eight years of follow-up, most of them did. About one in six women, though, had some trouble getting pregnant, including hundreds who experienced ovulatory infertility—a problem related to the maturation or release of a mature egg each month. When we compared their diets, exercise habits and other lifestyle choices with those of women who readily got pregnant, several key differences emerged. We have translated these differences into fertility-boosting strategies.

At least for now, these recommendations are aimed at preventing and reversing ovulatory infertility, which accounts for one quarter or more of all cases of infertility. They won't work for infertility due to physical impediments like blocked fallopian tubes. They may work for other types of infertility, but we don't yet have enough data to explore connections between

nutrition and infertility due to other causes. And since the Nurses' Health Study doesn't include information on the participants' partners, we weren't able to explore how nutrition affects male infertility. From what we have gleaned from the limited research in this area, some of our strategies might improve fertility in men, too. The plan described in The Fertility Diet doesn't guarantee a pregnancy any more than do in vitro fertilization or other forms of assisted reproduction. But it's virtually free, available to everyone, has no side effects, sets the stage for a healthy pregnancy, and forms the foundation of a healthy eating strategy for motherhood and beyond. That's a winning combination no matter how you look at it.

Slow Carbs, Not No Carbs

Once upon a time, and not that long ago, carbohydrates were the go-to gang for taste, comfort, convenience and energy. Bread, pasta, rice, potatoes—these were the highly recommended, base-of-the-food-pyramid foods that supplied us with half or more of our calories. Then it rumbled the Atkins and South Beach diets. In a scene out of George Orwell's "1984," good became bad almost overnight as the two weight-loss juggernauts turned carbohydrates into dietary demons, vilifying them as the source of big bellies and jiggling thighs. Following the no-carb gospel, millions of Americans spurned carbohydrates in hopes of shedding pounds. Then, like all diet fads great and small, the no-carb craze lost its luster and faded from prominence.

It had a silver lining, though, and not just for those selling low-carb advice and products. All the attention made scientists and the rest of us more aware of carbohydrates and their role in a healthy diet. It spurred several solid head-to-head comparisons of low-carb and low-fat diets that have given us a better understanding of how carbohydrates affect weight and weight loss. The new work supports the growing realization that carbohydrate choices have a major impact—for better and for worse—on the risk for heart disease, stroke, type 2 diabetes and digestive health.

New research from the Nurses' Health Study shows that carbohydrate choices also influence fertility. Eating lots of easily digested carbohydrates (fast carbs), such as white bread, potatoes and sugared sodas, increases the odds that you'll find yourself struggling with ovulatory infertility. Choosing slowly digested carbohydrates that are rich in fiber can improve fertility. This lines up nicely with work showing that a diet rich in these slow carbs and fiber before pregnancy helps prevent gestational diabetes, a common and worrisome problem for pregnant women and their babies. What do carbohydrates have to do with ovulation and pregnancy?

More than any other nutrient, carbohydrates determine your blood-sugar and insulin levels. When these rise too high, as they do in millions of individuals with insulin resistance, they disrupt the finely tuned balance of hormones needed for reproduction. The ensuing hormonal changes throw ovulation off-kilter.

Knowing that diet can strongly influence blood sugar and insulin, we wondered if carbohydrate choices could influence fertility in average, relatively healthy women. The answer from the Nurses' Health Study was yes. We started by grouping the study participants from low daily carbohydrate intake to high. One of the first things we noticed was a connection between high carbohydrate intake and healthy lifestyles.

Women in the high-carb group, who got nearly 60 percent of their calories from carbs, ate less fat and animal protein, drank less alcohol and coffee, and consumed more plant protein and fiber than those in the low-carb group, who got 42 percent of calories from carbohydrates. Women in the top group also weighed less, weren't as likely to smoke and were more physically active. This is a good sign that carbohydrates can be just fine for health, especially if you choose good ones.

The *total* amount of carbohydrate in the diet wasn't connected with ovulatory infertility. Women in the low-carb and high-carb groups were equally likely to have had fertility problems. That wasn't a complete surprise. As we described earlier, different carbohydrate sources can have different effects on blood sugar, insulin and long-term health.

Evaluating total carbohydrate intake can hide some important differences. So we looked at something called the glycemic load. This relatively new measure conveys information about both the amount of carbohydrate in the diet and how quickly it is turned to blood sugar. The more fast carbs in the diet, the higher the glycemic load. (For more on glycemic load, go to health.harvard.edu/newsweek.) Women in the highest glycemic-load category were 92 percent more likely to have had ovulatory infertility than women in the lowest category, after accounting for age, smoking, how much animal and vegetable protein they ate, and other factors that can also influence fertility. In other words, eating a lot of easily digested carbohydrates increases the odds of ovulatory infertility, while eating more slow carbs decreases the odds.

Because the participants of the Nurses' Health Study complete reports every few years detailing their average daily diets, we were able to see if certain foods contributed to ovulatory infertility more than others. In general, cold breakfast cereals, white rice and potatoes were linked with a higher risk of ovulatory infertility. Slow carbs, such as brown rice, pasta and dark bread, were linked with greater success getting pregnant.

Computer models of the nurses' diets were also revealing. We electronically replaced different nutrients with carbohydrates. Most of these substitutions didn't make a difference. One, though, did. Adding more carbohydrates at the expense of naturally occurring fats predicted a decrease in fertility. This could very well mean that natural fats, especially unsaturated fats, improve ovulation when they replace easily digested carbohydrates.

In a nutshell, results from the Nurses' Health Study indicate that the *amount* of carbohydrates in the diet doesn't affect fertility, but the *quality* of those carbohydrates does. Eating a lot of rapidly digested carbohydrates that continually boost your blood-sugar and insulin levels higher can lower your chances of getting pregnant. This is especially true if you are eating carbohydrates in place of healthful unsaturated fats. On the other hand, eating whole grains, beans, vegetables and whole fruits—all of which are good sources of slowly digested carbohydrates—can improve ovulation and your chances of getting pregnant.

Balancing Fats

In 2003, the government of Denmark made a bold decision that is helping protect its citizens from heart disease: it essentially banned trans fats in fast food, baked goods and other commercially prepared foods. That move may have an unexpected effect—more little Danes. Exciting findings from the Nurses' Health Study indicate that trans fats are a powerful

deterrent to ovulation and conception. Eating less of this artificial fat can improve fertility, and simultaneously adding in healthful unsaturated fats whenever possible can boost it even further.

Women, their midwives and doctors, and fertility researchers have known for ages that body fat and energy stores affect reproduction. Women who don't have enough stored energy to sustain a pregnancy often have trouble ovulating or stop menstruating altogether. Women who have too much stored energy often have difficulty conceiving for other reasons, many of which affect ovulation. These include insensitivity to the hormone insulin, an excess of male sex hormones and overproduction of leptin, a hormone that helps the body keep tabs on body fat.

A related issue is whether *dietary* fats influence ovulation and reproduction. We were shocked to discover that this was largely uncharted territory. Until now, only a few studies have explored this connection. They focused mainly on the relationship between fat intake and characteristics of the menstrual cycle, such as cycle length and the duration of different phases of the cycle. In general, these studies suggest that more fat in the diet, and in some cases more saturated fat, improves the menstrual cycle. Most of these studies were very small and didn't account for total calories, physical activity or other factors that also influence reproduction. None of them examined the effect of dietary fat on fertility.

The dearth of research in this area has been a gaping hole in nutrition research. If there is a link between fats in the diet and reproduction, then simple changes in food choices could offer delicious, easy and inexpensive ways to improve fertility. The Nurses' Health Study research team looked for connections between dietary fats and fertility from a number of different angles. Among the 18,555 women in the study, the total amount of fat in the diet wasn't connected with ovulatory infertility once weight, exercise, smoking and other factors that can influence reproduction had been accounted for. The same was true for cholesterol, saturated fat and monounsaturated fat—none were linked with fertility or infertility. A high intake of polyunsaturated fat appeared to provide some protection against ovulatory infertility in women who also had high intakes of iron, but the effect wasn't strong enough to be sure exactly what role this healthy fat plays in fertility and infertility.

Trans fats were a different story. Across the board, the more trans fat in the diet, the greater the likelihood of developing ovulatory infertility. We saw an effect even at daily trans fat intakes of about four grams a day. That's less than the amount the average American gets each day.

Eating more trans fat usually means eating less of another type of fat or carbohydrates. Computer models of the nurses' diet patterns indicated that eating a modest amount of trans fat (2 percent of calories) in place of other, more healthful nutrients like polyunsaturated fat, monounsaturated fat or carbohydrate would dramatically increase the risk of infertility. To put this into perspective, for someone who eats 2,000 calories a day, 2 percent of calories translates into about four grams of trans fat. That's the amount in two tablespoons of stick margarine, one medium order of fast-food french fries or one doughnut.

Fats aren't merely inert carriers of calories or building blocks for hormones or cellular machinery. They sometimes have powerful biological effects, such as turning genes on or off,

revving up or calming inflammation and influencing cell function. Unsaturated fats do things to improve fertility—increase insulin sensitivity and cool inflammation—that are the opposite of what trans fats do. That is probably why the largest decline in fertility among the nurses was seen when trans fats were eaten instead of monounsaturated fats.

The Protein Factor

At the center of most dinner plates sits, to put it bluntly, a hunk of protein. Beef, chicken and pork are Americans' favorites, trailed by fish. Beans lag far, far behind. That's too bad. Beans are an excellent source of protein and other needed nutrients, like fiber and many minerals. And by promoting the lowly bean from side dish to center stage and becoming more inventive with protein-rich nuts, you might find yourself eating for two. Findings from the Nurses' Health Study indicate that getting more protein from plants and less from animals is another big step toward walking away from ovulatory infertility.

Scattered hints in the medical literature that protein in the diet may influence blood sugar, sensitivity to insulin and the production of insulin-like growth factor-1—all of which play important roles in ovulation—prompted us to look at protein's impact on ovulatory infertility in the Nurses' Health Study.

We grouped the participants by their average daily protein intake. The lowest-protein group took in an average of 77 grams a day; the highest, an average of 115 grams. After factoring in smoking, fat intake, weight and other things that can affect fertility, we found that women in the highest-protein group were 41 percent more likely to have reported problems with ovulatory infertility than women in the lowest-protein group.

When we looked at animal protein intake separately from plant protein, an interesting distinction appeared. Ovulatory infertility was 39 percent more likely in women with the highest intake of animal protein than in those with the lowest. The reverse was true for women with the highest intake of plant protein, who were substantially less likely to have had ovulatory infertility than women with the lowest plant protein intake.

That's the big picture. Computer models helped refine these relationships and put them in perspective. When total calories were kept constant, adding one serving a day of red meat, chicken or turkey predicted nearly a one-third increase in the risk of ovulatory infertility. And while adding one serving a day of fish or eggs didn't influence ovulatory infertility, adding one serving a day of beans, peas, tofu or soybeans, peanuts or other nuts predicted modest protection against ovulatory infertility.

Eating more of one thing means eating less of another, if you want to keep your weight stable. We modeled the effect that juggling the proportions of protein and carbohydrate would have on fertility. Adding animal protein instead of carbohydrate was related to a greater risk of ovulatory infertility. Swapping 25 grams of animal protein for 25 grams of carbohydrates upped the risk by nearly 20 percent. Adding plant protein instead of carbohydrates was related to a lower risk of ovulatory infertility. Swapping 25 grams of plant protein for 25 grams of carbohydrates shrank the risk by 43 percent. Adding plant protein instead of animal protein was even more effective. Replacing 25 grams of animal protein with 25 grams of plant protein was related to a 50 percent lower risk of ovulatory infertility.

These results point the way to another strategy for overcoming ovulatory infertility—eating more protein from plants and less from animals. They also add to the small but growing body of evidence that plant protein is somehow different from animal protein.

Milk and Ice Cream

Consider the classic sundae: a scoop of creamy vanilla ice cream crisscrossed by rivulets of chocolate sauce, sprinkled with walnuts and topped with a spritz of whipped cream. If you are having trouble getting pregnant, and ovulatory infertility is suspected, think of it as temporary health food. OK, maybe that's going a bit too far. But a fascinating finding from the Nurses' Health Study is that a daily serving or two of whole milk and foods made from whole milk—full-fat yogurt, cottage cheese, and, yes, even ice cream—seem to offer some protection against ovulatory infertility, while skim and low-fat milk do the opposite.

The results fly in the face of current standard nutrition advice. But they make sense when you consider what skim and low-fat milk do, and don't, contain. Removing fat from milk radically changes its balance of sex hormones in a way that could tip the scales against ovulation and conception. Proteins added to make skim and low-fat milk look and taste "creamier" push it even farther away.

It would be an overstatement to say that there is a handful of research into possible links between consumption of dairy products and fertility. The vanishingly small body of work in this area is interesting, to say the least, given our fondness for milk, ice cream and other dairy foods. The average American woman has about two servings of dairy products a day, short of the three servings a day the government's dietary guidelines would like her to have.

The depth and detail of the Nurses' Health Study database allowed us to see which foods had the biggest effects. The most potent fertility food from the dairy case was, by far, whole milk, followed by ice cream. Sherbet and frozen yogurt, followed by low-fat yogurt, topped the list as the biggest contributors to ovulatory infertility. The more low-fat dairy products in a woman's diet, the more likely she was to have had trouble getting pregnant. The more full-fat dairy products in a woman's diet, the less likely she was to have had problems getting pregnant.

Our advice on milk and dairy products might be criticized as breaking the rules. The "rules," though, aren't based on solid science and may even conflict with the evidence. And for solving the problem of ovulatory infertility, the rules may need tweaking. Think about switching to full-fat milk or dairy products as a temporary nutrition therapy designed to improve your chances of becoming pregnant. If your efforts pay off, or if you stop trying to have a baby, then you may want to rethink dairy—especially whole milk and other full-fat dairy foods—altogether. Over the long haul, eating a lot of these isn't great for your heart, your blood vessels or the rest of your body.

Before you sit down to a nightly carton of Häagen-Dazs ("*The Fertility Diet* said I needed ice cream, honey"), keep in mind that it doesn't take much in the way of full-fat dairy foods to measurably affect fertility. Among the women in the Nurses' Health Study, having just one serving a day of a full-fat dairy food, particularly milk, decreased the chances of having ovulatory infertility. The impact of ice cream was seen at two half-cup servings a week. If you eat ice cream at that rate, a pint should last about two weeks.

Equally important, you'll need to do some dietary readjusting to keep your calorie count and your waistline from expanding. Whole milk has nearly double the calories of skim milk. If you have been following the U.S. government's poorly-thought-out recommendation and are drinking three glasses of milk a day, trading skim milk for whole means an extra 189 calories a day. That could translate into a weight gain of 15 to 20 pounds over a year if you don't cut back somewhere else. Those extra pounds can edge aside any fertility benefits you might get from dairy foods. There's also the saturated fat to consider, an extra 13 grams in three glasses of whole milk compared with skim, which would put you close to the healthy daily limit.

Aim for one to two servings of dairy products a day, both of them full fat. This can be as easy as having your breakfast cereal with whole milk and a slice of cheese at lunch or a cup of whole-milk yogurt for lunch and a half-cup of ice cream for dessert. Easy targets for cutting back on calories and saturated fat are red and processed meats, along with foods made with fully or partially hydrogenated vegetable oils.

Once you become pregnant, or if you decide to stop trying, going back to low-fat dairy products makes sense as a way to keep a lid on your intake of saturated fat and calories. You could also try some of the nondairy strategies for getting calcium and protecting your bones. If you don't like milk or other dairy products, or they don't agree with your digestive system, don't force yourself to have them. There are many other things you can do to fight ovulatory infertility. This one is like dessert—enjoyable but optional.

The Role of Body Weight

Weighing too much or too little can interrupt normal menstrual cycles, throw off ovulation or stop it altogether. Excess weight lowers the odds that in vitro fertilization or other assisted reproductive technologies will succeed. It increases the chances of miscarriage, puts a mother at risk during pregnancy of developing high blood pressure (pre-eclampsia) or diabetes, and elevates her chances of needing a Cesarean section. The dangers of being overweight or underweight extend to a woman's baby as well.

Weight is one bit of information that the participants of the Nurses' Health Study report every other year. By linking this information with their accounts of pregnancy, birth, miscarriage and difficulty getting pregnant, we were able to see a strong connection between weight and fertility. Women with the lowest and highest Body Mass Indexes (BMI) were more likely to have had trouble with ovulatory infertility than women in the middle. Infertility was least common among women with BMIs of 20 to 24, with an ideal around 21.

Keep in mind that this is a statistical model of probabilities that links weight and fertility. It doesn't mean you'll get pregnant only if you have a BMI between 20 and 24. Women with higher and lower BMIs than this get pregnant all the time without delay or any medical help. But it supports the idea that weighing too much or too little for your frame can get in the way of having a baby.

We call the range of BMIs from 20 to 24 the fertility zone. It isn't magic—nothing is for fertility—but having a weight in that range seems to be best for getting pregnant. If you aren't in or near the zone, don't despair. Working to move your BMI in that direction by gaining or losing some weight is almost as good. Relatively small changes are often enough to have the

desired effects of healthy ovulation and improved fertility. If you are too lean, gaining five or 10 pounds can sometimes be enough to restart ovulation and menstrual periods. If you are overweight, losing 5 percent to 10 percent of your current weight is often enough to improve ovulation.

Being at a healthy weight or aiming toward one is great for ovulatory function and your chances of getting pregnant. The "side effects" aren't so bad, either. Working to achieve a healthy weight can improve your sensitivity to insulin, your cholesterol, your blood pressure and your kidney function. It can give you more energy and make you look and feel better.

While dietary and lifestyle contributions to fertility and infertility in men have received short shrift, weight is one area in which there has been some research. A few small studies indicate that overweight men aren't as fertile as their healthy-weight counterparts. Excess weight can lower testosterone levels, throw off the ratio of testosterone to estrogen (men make some estrogen, just as women make some testosterone) and hinder the production of sperm cells that are good swimmers. A study published in 2006 of more than 2,000 American farmers and their wives showed that as BMI went up, fertility declined. In men, the connection between increasing weight and decreasing fertility can't yet be classified as rock solid. But it is good enough to warrant action, mainly because from a health perspective there aren't any downsides to losing weight if you are overweight. We can't define a fertility zone for weight in men, nor can anyone else. In lieu of that, we can say to men who are carrying too many pounds that shedding some could be good for fertility and will be good for overall health.

The Importance of Exercise

Baby, we were born to run. That isn't just the tagline of Bruce Springsteen's anthem to young love and leavin' town. It's also a perfect motto for getting pregnant and for living a long, healthy life. Inactivity deprives muscles of the constant push and pull they need to stay healthy. It also saps their ability to respond to insulin and to efficiently absorb blood sugar. When that leads to too much blood sugar and insulin in the bloodstream, it endangers ovulation, conception and pregnancy. Physical activity and exercise are recommended and even prescribed for almost everyone—except women who are having trouble getting pregnant. Forty-year-old findings that too much exercise can turn off menstruation and ovulation make some women shy away from exercise and nudge some doctors to recommend avoiding exercise altogether, at least temporarily. That's clearly the right approach for women who exercise hard for many hours a week and who are extremely lean. But taking it easy isn't likely to help women who aren't active or those whose weights are normal or above where they should be. In other words, the vast majority of women.

Some exciting results from the Nurses' Health Study and a handful of small studies show that exercise can be a boon for fertility. These important findings are establishing a vital link between activity and getting pregnant. Much as we would like to offer a single prescription for conception-boosting exercise, however, we can't. Some women need more exercise than others, for their weight or moods, and others are active just because they enjoy it. Some who need to be active aren't, while a small number of others may be too active.

Instead of focusing on an absolute number, try aiming for the fertility zone. This is a range of exercise that offers the biggest window of opportunity for fertility. Being in the fertility zone means you aren't overdoing or underdoing exercise. For most women, this means getting at

least 30 minutes of exercise every day. But if you are carrying more pounds than is considered healthy for your frame (i.e., a BMI above 25), you may need to exercise for an hour or more. If you are quite lean (i.e., your BMI is 19 or below), aim for the middle of the exercise window for a few months. Keep in mind that the fertility zone is an ideal, not an absolute. Hospital delivery rooms are full of women who rarely, or never, exercise. Not everyone is so lucky. If you are having trouble getting pregnant, then maybe the zone is the right place for you.

Whether you classify yourself as a couch potato or an exercise aficionado, your fertility zone should include four types of activity: aerobic exercise, strength training, stretching and the activities of daily living. This quartet works together to control weight, guard against high blood sugar and insulin, and keep your muscles limber and strong. They are also natural stress relievers, something almost everyone coping with or worrying about infertility can use.

Exercise has gotten a bad rap when it comes to fertility. While the pioneering studies of Dr. Rose Frisch and her colleagues convincingly show that too much exercise coupled with too little stored energy can throw off or turn off ovulation in elite athletes, their work says nothing about the impact of usual exercise in normal-weight or overweight women. Common sense says that it can't be a big deterrent to conception. If it were, many of us wouldn't be here. Our ancestors worked hard to hunt, forage, clear fields and travel from place to place. Early *Homo sapiens* burned twice as many calories each day as the average American does today and were fertile despite it—or because of it.

Results from the Nurses' Health Study support this evolutionary perspective and show that exercise, particularly vigorous exercise, actually improves fertility. Exercising for at least 30 minutes on most days of the week is a great place to start. It doesn't really matter how you exercise, as long as you find something other than your true love that moves you and gets your heart beating faster.

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