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Diet and female fertility: doctor, what should I eat?

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Fecundity is the capacity to produce offspring. Identifying dietary factors that influence human fecundity is of major clinical and public health significance. This review focuses on the evidence from epidemiologic literature for the relationships between key nutritional factors and female reproductive potential. According to existing data, women trying to achieve pregnancy are encouraged to increase consumption of whole grains, omega-3 fatty acids, fish, and soy and to reduce consumption of *trans* fats and red meat. In addition, a daily multivitamin that contains folic acid before and during pregnancy may not only prevent birth defects, but also improve the chance of achieving and maintaining a pregnancy. In contrast, there is limited evidence supporting an association between vitamin D and human fecundity outcomes despite promising evidence from nonhuman studies. Questions for future research included the roles of other types of fat (especially omega-6 and monounsaturated fats) and protein (especially white meat and seafood) on female fertility; particular attention should also be paid to exposure to environmental contaminants in foods. Although much work remains, this review accrued best available evidence to provide practical dietary recommendations for women trying to conceive. (Fertil Steril® 2018;110:560–9. ©2018 by American Society for Reproductive Medicine.)

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It is estimated that infertility affects 15.5% of reproductive-age women in the United States (1), and 30% of pregnancies are lost after implantation (2). Although assisted reproductive technologies (ART) become a common treatment choice, because of the financial and emotional challenges associated with ART, emerging scientific efforts focus on the identification of modifiable factors, such as diet and lifestyles, that may affect fertility. Dietary factors have been implicated in the pathology of multiple disorders (3–6), and the idea that dietary changes may boost fertility appears to be promising.

Human fecundity is difficult to assess directly. Therefore, most researchers rely on proxy measures, such as assessment of time to pregnancy (a shorter time indicating a higher fecundity) and whether a pregnancy, pregnancy loss, or live birth occurs among pregnancy planners or women undergoing ART. Other commonly used fecundity proxies include medically determined causes of infertility, reproductive hormonal profiles and menstrual irregularities (to assess ovulatory function), and ovarian antral follicle counts as well as serum levels of antimüllerian hormone (to assess ovarian reserve). In this review, we summarize the evidence from human studies relating diet to these markers of fecundity for the purpose of providing a tool to counsel patients trying to achieve pregnancy.

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MICRONUTRIENTS

Folic Acid

Folate, involved in the synthesis of DNA (7), is crucial in gametogenesis, fertilization, and pregnancy (8, 9). Therefore, folate (natural form of vitamin B9) or folic acid (synthetic form of vitamin B9) may play an important role in human reproduction.

Folic acid and the risk for spontaneous abortion. Since the early 1990, the U.S. Public Health Service and Centers for Disease Control and Prevention have recommended that all women of childbearing age take a daily supplement containing 0.4–0.8 mg folic acid to prevent neural tube defects (10). In the mid-1990s, controversy over the safety of folic acid supplementation arose when three studies reported increased spontaneous abortion (SAB) rates among folic acid users (11–13). The validity of these findings was later challenged on methodologic grounds (14, 15), and in the most recent Cochrane review (16), on the basis of three randomized trials

(11, 17, 18), daily folic acid (0.8 mg in one study and 4 mg in two studies) plus multivitamin supplementation before and during pregnancy did not increase SAB rates among users versus nonusers. Similarly, a large population-based study in China found no increased risk for SAB among daily consumers of folic acid (19), and a Brazilian multicenter trial reported no difference in SAB rates between high and low folic acid supplementation groups (0.4 vs. 4 mg/d) (20). Interestingly, recent data from observational studies, including a large prospective cohort of healthy women in the Nurse's Healthy Study II (NHS-II), suggested a reduced SAB risk among women using folic acid before or during early pregnancy, particularly at intake levels well above those recommended for the prevention of neural tube defects (21–23).

Folic acid, fecundity, and ovulatory infertility. The associations between folic supplementation and infertility have also been examined in three prospective cohort studies, which in general suggested a protective effect. Specifically, among women from the NHS-II study, multivitamin users had approximately one-third lower risk of developing ovulatory infertility compared to nonusers, and folic acids appeared to explain most of this association (24). Similarly, folate intake was related to a lower frequency of sporadic anovulation in a prospective cohort of young healthy women (the Biocycle study) (25) and to a shorter time to pregnancy among pregnancy planners in a large Danish cohort (26).

Folic acid and ART outcomes. Studies among subfertile women generally suggest a favorable effect of folate supplementation on ART outcomes. In a small randomized controlled trial (RCT) of subfertile women, women who took a daily multivitamin (containing 0.4 mg folic acid) had 16% higher probability of pregnancy than women in the placebo group (27). In addition, in two studies, the *MTHFR* 677T allele mutation (leading to lower MTHFR enzyme activity and lower serum folate levels) was associated with poor ovarian response, fewer retrieved oocytes (28), and lower granulosa-cell E_2 production than the wild-type allele (29). Furthermore, in a prospective ART cohort in Boston (EARTH study), women consuming >0.8 mg/d folate compared with those consuming <0.4 mg/d, before conception, had a higher probability of live birth (30). In this same study, higher serum levels of folate and vitamin B_{12} measured during the stimulation phase of the cycle were associated with a higher probability of live birth (31). Nonetheless, the results from three European cohort studies of folate and ART outcomes did not show similar benefits (32–34). The latter results, however, should be interpreted with caution considering they excluded women who failed before embryo transfer. If folates affect early ART outcomes, as suggested by some studies (30, 35–37), then excluding these women could bias the results toward the null.

Summary. Overall, current evidence generally supports folic acid supplementation before and during pregnancy, because it appears that folate is not associated with higher risks of SAB but may instead improve a woman's chance of achieving and maintaining a pregnancy. Benefits seem to appear at intakes above those recommended for the prevention of neural tube defects, but trials testing these doses in relation to fertility are lacking.

Vitamin D

Accruing literature suggests that vitamin D may modulate reproductive processes. Vitamin D receptors are widely distributed across the reproductive system, including ovaries, uterus, and endometrium (38). Animal studies have shown that female rodents fed a vitamin D deficient diets, as well as knockouts for vitamin D receptors and 1α-hydroxylase (enzyme responsible for converting circulating 25-hydroxy vitamin D_3 [25(OH]D) to its biologically active form) have reduced fertility (39–43). Furthermore, vitamin D stimulates ovarian steroidogenesis, promotes follicular maturation, and regulates HOXA10 expression (involved in successful implantation) (44, 45), and its deficiency may be involved in the pathogenesis of polycystic ovary syndrome (PCOS).

Vitamin D and reproductive outcomes. Despite a promising role of vitamin D in reproduction in nonhuman animal studies, studies evaluating the relation between vitamin D and fecundity in healthy human populations generally show no strong associations. Among women participating in the NHS-II study, vitamin D intake was unrelated to anovulatory infertility (46). Similarly, vitamin D concentrations were not associated with either the overall probability of conception (among healthy Danish women) (47) or conception in less than 1 year (among Italian women undergoing routine aneuploidy screening) (48). Furthermore, a meta-analysis (49) of 10,630 pregnant women from five cohort studies (50–54) revealed no association between low 25(OH) D levels and SAB risks, although extremely low levels (<20 ng/mL) were associated with increased early SAB risk in a subgroup analysis of two studies (50, 53).

Vitamin D and ART outcomes. Results concerning a possible role of vitamin D on ART outcomes are inconsistent. In a recent meta-analysis of 11 cohort studies (five prospective [55–59] and six retrospective [60–65]) of women undergoing ART (66), Chu et al. found that women replete in vitamin D, compared with women with either deficient or insufficient vitamin D levels, had higher probability of clinical pregnancy and live birth. No association of vitamin D with probability of miscarriage was noted (66). Similarly, a post hoc analysis of an RCT in PCOS patients found that serum 25(OH)D <30 versus >30 ng/mL was associated with lower live birth rates (67). In contrast, three small observational studies, not included in this meta-analysis, found no association between serum or follicular fluid vitamin D concentrations and ART outcomes (68–70). Furthermore, findings from two small RCTs did not support the administration of vitamin D to improve pregnancy outcomes (71, 72). Neither weekly supplementation of 50,000 IU vitamin D for 6–8 weeks to deficient women (71) nor administration of megadose vitamin D (300,000 IU) to women with PCOS improved reproductive outcomes (72). In the latter, a significant increase in endometrial thickness was noted but did not translate to a significantly higher probability of pregnancy (72).

Summary. Despite there being promising mechanisms through which vitamin D can affect reproduction, evidence from epidemiologic studies remains inconclusive, though suggestive that serum levels in the deficiency range are related to worse outcomes in ART. Larger RCTs are required to examine the effect of vitamin D supplementation on fertility, as well as to determine who will benefit from the supplementation and at what doses.

MACRONUTRIENTS

Carbohydrates

Both quality and quantity of dietary carbohydrates influence glucose homeostasis and insulin sensitivity (73), which may in turn influence ovarian androgen production and ovarian function. The common indicators of carbohydrate quality include glycemic index (an index to indicate the effect of carbohydrate on blood glucose), glycemic load (a product of glycemic index and amount of carbohydrates), the extent to which carbohydrate have been refined (whole grains vs. refined grains), and amount of dietary fiber.

Glycemic load and reproductive outcomes. In NHS-II, both total carbohydrate consumption and glycemic load were associated with higher risks of ovulatory infertility (74). Consistently with this finding, several studies showed that women with PCOS more often exhibit a dietary pattern marked by a greater consumption of high-glycemic-index foods compared with normoandrogenic women (75–77). Reduction in dietary carbohydrates among PCOS women improved insulin sensitivity (78–80) and decreased circulating testosterone levels (79), potentially enhancing ovulatory function. Nonetheless, among healthy regularly menstruating women, dietary carbohydrate intake was unrelated to androgens and relevant hormones (testosterone, antimüllerian hormone, insulin) (81), possibly owing to a relatively narrow range of hormone concentrations in the healthy population.

Whole grains and ART outcomes. Whole grains and constituents of whole grains (including phytic acid, vitamins, and selenium), which have antioxidant antiinflammatory properties and beneficial effects on glucose metabolism, may potentially boost fertility because insulin resistance and oxidative damage have been implicated in the pathogenesis of subfertility (82). Furthermore, lignan (83), the hormonally active compound in whole grains, through its proestrogeneic and antiestrogenic effects, may exert reproductive benefits. A prospective study of women attending a fertility clinic (EARTH study) showed that higher preconception intake of whole grain was associated with higher probability of live birth (84).

Dietary fiber and reproductive and ART outcomes. In a couple of clinical trials of premenopausal women, high-fiber/low-fat diet was associated with reduced estrogen levels (85–89), presumably because high-fiber diet decreases fecal β-glucuronidase activity, thus decreasing reabsorption of estrogen (90). Similarly, in a study of regularly menstruating women (the Biocycle study), a diet high in fiber was associated with decreased E_2 levels (91). Regarding its association with ovulation, a diet rich in fiber was associated with an increased risk of anovulation in one study (91) but was unrelated to ovulatory infertility in the long run in another (NHS-II) (74). Furthermore, total fiber intake was unrelated to ART success among women undergoing fertility treatments (EARTH Study), but intake of bran was responsible for the positive association between whole grains and live birth rates described above (84).

Summary. Current evidence, though limited, suggests that a diet low in glycemic load and containing greater amounts of whole grains may benefit fecundity, and that a diet rich in fiber may reduce estrogen levels but may not affect either the risk of infertility or ART outcomes.

Fatty Acids

Fatty acids, commonly classified as saturated (SFA), monounsaturated (MUFA), and polyunsaturated (PUFA; including ω-3 PUFA and ω-6 PUFA), may play important roles on reproductive function through myriad pathways. For one, fatty acids are used as energy substrates during oocyte maturation and early embryo development (92), and they serve as critical precursors for a variety of substrates (e.g., prostaglandins and steroid hormones) playing a vital role in implantation and pregnancy maintenance (93). On the other hand, *trans* fatty acids increase insulin resistance (94), thus adversely affecting the ovulation process (95).

***Trans* fat in ovulatory infertility, endometriosis, and fecundity.** In a cohort of regularly menstruating healthy women (the Biocycle study), *trans* fat was unrelated to either hormone concentrations or risks of anovulation (96). However, in the NHS-II study, consuming *trans* fat instead of carbohydrate or other unsaturated fat was associated with higher risks of ovulatory infertility (97) and laparoscopically confirmed endometriosis (98). Furthermore, *trans* fat intake was associated with reduced fecundability in a large North American preconception cohort (PRESTO study) (99). However, no such association was observed in a similar Danish preconception cohort (Snart Foraeldre study), where *trans* fat intake was low (99).

ω-3 PUFA and fecundity, ovulatory infertility, and ovarian aging. In the Biocycle study, increased long-chain ω-3 PUFA intake was associated with increases in luteal progesterone concentration; furthermore, docosapentaenoic acid (a type of long-chain ω-3 PUFA) was associated with increased total E_2 and lower risk of anovulation (96). Although no association was identified between ω-3 PUFA and ovulatory infertility in the NHS-II study (97), an association between greater consumption of ω-3 PUFA and a lower risk of endometriosis was noted (98). Furthermore, ω-3 PUFA was associated with higher fecundability among women who did not use fish oil supplements in the PRESTO study (U.S. and Canada), although no association was found in the Snart Foraeldre cohort (Denmark), among whom baseline intake was significantly higher (99).

Regarding potential effects on ovarian reserve, dietary administration of ω-3 PUFA decreased serum FSH levels in normal-weight but not in obese women with normal ovarian reserve (100), which is consistent with murine data whereby higher dietary ω-3 PUFA delayed ovarian aging (101).

ω-3 PUFA and ART outcomes. The favorable associations between ω-3 PUFA and reproductive end points were identified in ART settings as well. The EARTH study reported that for every 1% increase in serum long-chain ω-3 PUFA levels, the probability of clinical pregnancy and live birth increased by 8% (102). In another study, serum levels of eicosapentaenoic acid (a long-chain ω-3 PUFA) were significantly higher in pregnant than in nonpregnant patients (103). In addition, higher preconception ω-3 PUFA intake was associated with better embryo morphology, despite being inversely associated with response to ovarian stimulation (104). Furthermore, although Jungheim et al. found, in a small ART cohort of 91 women, that serum α-linolenic acid (ALA; a type of ω-3 PUFA) concentrations were associated with decreased chances of pregnancy (105), in a subsequent analysis of a larger number of women ($n = 200$), the authors reported no association between any individual PUFA and ART outcomes (106). Finally, despite Jungheim et al. finding a positive association between the ratio of linoleic acid (LA) to ALA with higher implantation and pregnancy rates (106), that finding was not replicated in the EARTH cohort (102).

ω-6 PUFA and ART outcomes. Results concerning ω-6 PUFA were less consistent across studies. In a small study of overweight and obese women undergoing ART, preconception intake of ω-6 PUFA (especially LA) was associated with improved pregnancy rates (107). In another, though, follicular fluid levels of LA negatively correlated with metaphase II oocytes. Similarly, in the EARTH study, serum LA levels were inversely associated with total oocyte and metaphase II oocyte yield, but this association did not translate into differences in implantation, clinical pregnancy, or live birth (102).

Summary. Taken together, higher ω-3 PUFA and lower *trans* fatty acid intake may enhance female fertility. The effect of other fatty acids, including ω-6 PUFA, SFA, and MUFA, on fertility is less clear.

Protein

The daily recommended dietary allowance of protein for a healthy adult with minimal physical activity is 0.8 g per kg of body weight. Recommendations on protein intake (amount and type) for women attempting conception or undergoing fertility treatments do not exist, and the controversy surrounding the evidence on animal and dairy protein as well as soy and phytoestrogens remains. Concerns have arisen because of the potential for contamination of dietary protein sources by pesticides and endocrine-disrupting chemicals (108–110) and the presence in them of measurable amounts of steroid hormones and growth factors (111–114) that when absorbed may alter reproductive outcomes. The mechanisms involved are unknown, but absorbed contaminants may alter serum levels of growth factors or adversely affect either the hypothalamic-pituitary-gonadal axis or the oocyte and its local supporting environment through modifications of gene expression and neuroendocrine signaling (115–120).

Dairy and ovarian reserve. Earlier studies in rodents showed that in galactose-exposed mice puberty was delayed, response to gonadotropins was blunted, and follicular reserve was decreased, suggesting that dairy's high galactose content might have a negative impact on ovarian physiology (121). In human populations with higher per-capita consumption of milk, the decline in fertility with aging was steeper and fertility at older ages was lower (122). Similarly, higher dairy protein intake, and not total protein intake, was associated with lower ovarian antral follicle counts among women presenting for infertility treatment (123). Although these findings suggest a possible negative impact of dairy on ovarian reserve, studies evaluating its impact on either overall fertility or ovulatory infertility do not support a similar adverse effect.

Dairy and fertility. Consumption of three or more glasses of milk per day was protective of female fertility in an agricultural population in Wisconsin (124). In the NHS-II study no relation was found between total dairy intake and risk of ovulatory infertility, however anovulatory infertility was positively associated with low-fat and inversely associated with high-fat dairy intake (46). Similarly, the Biocycle study (125) reported that sporadic anovulation was more common among women consuming higher amounts of cream and yogurt. In the same study, total and low- and high-fat dairy food intakes were associated with a ~5% reduction in serum E_2 concentrations, and total and high-fat dairy food intakes were positively associated with serum lLH.

Associations between dairy intake and fecundability in two separate cohorts of Danish and North American pregnancy planners (Snart Foraeldre and PRESTO, respectively) were inconsistent across cohorts. Total dairy and milk consumption was associated with increased fecundability in Denmark (where most milk is low-fat), whereas in the PRESTO cohort, there was little association between fecundability and dairy intake. In the latter, it was only among women younger than 30 years of age that cheese and high-dairy intake was associated with increased fecundability (126).

Dairy and ART outcomes. Finally, in a prospective cohort of women undergoing ART, dairy intake was positively associated with live birth only among women older than 35 years of age (127). Nevertheless, dairy food intake was not related to any of the evaluated intermediate outcomes (ie: response to gonadotropins, embryonic development, implantation and clinical pregnancy). The observed association did not differ between full-fat and low-fat dairy foods and did not appear to be driven by one single dairy food item (127).

Animal protein and reproductive outcomes. Regarding protein intake from nondairy sources and its effect on reproductive outcomes, available data point toward complex interactions between dietary protein and environmental contaminants. Ovarian antral follicle counts were not affected by either vegetable or animal protein intake from nondairy sources among women attending a fertility clinic (123). However, ovulation was negatively affected by increased meat intake among NHS-II participants. Intakes of fish, eggs, and processed meats did not seem to have an effect on anovulation, although increased vegetable protein intake seemed to decrease the risk (128). Similarly, blastocyst formation following ART was decreased among patients consuming more red meat. However, blastocyst formation was positively affected by fish consumption (129).

Regarding seafood consumption, most of the concerns relate to the fact that fish intake is the major pathway through which humans are exposed to methyl mercury (130). Although early data indicated that mercury in fish may interfere with the endocrine system and impair fertility (131–133), recent prospective studies found no associations between mercury concentrations and in vitro fertilization end points (134) and time to pregnancy (135). Furthermore, strong relations between fish intake and shorter time to pregnancy (136), as well as between ω-3 PUFA and higher fecundability among non–fish oil supplement takers (99), support the benefits of consumption of fish with low mercury levels and high concentrations of ω-3 PUFA (99, 137). These findings were consistent with the most recent advice from the American College of Obstetricians and Gynecologists that pregnant women and those who may become pregnant are encouraged to eat two to three servings of a variety of fish per week, with no more than one serving per week of fish such as albacore tuna, and to avoid fish (e.g., bigeye tuna, king mackerel, swordfish) with the highest mercury concentrations (138).

Soy and reproductive outcomes. Given the available evidence suggesting that certain phytoestrogens may affect endocrine processes by influencing estrogen-dependent pathways (139–142), it is hypothesized that soy consumption by women attempting conception might affect fertility. Regarding a possible effect on ovarian aging, a limited number of studies evaluated a possible impact on serum FSH levels as a marker of ovarian reserve. Because the studies were small and heterogeneous and did not evaluate more precise markers of ovarian reserve, such as antimüllerian hormone and antral follicle counts, it is difficult to draw any definite conclusions (143–147). One would assume that if a deleterious effect of soy and phytoestrogens on ovarian aging exists, its consumption would accelerate the onset of menopause. From the available data, no such association between soy isoflavones and age at menopause has been observed (148–151). Regarding fecundity of populations with no history of infertility, women with the highest isoflavone intake participating in the retrospective Adventist Health Study were more likely to be childless, whereas no relation between soy intake and fecundity was noted in a prospective cohort of couples attempting pregnancy (152, 153). In women seeking fertility treatments, however, soy isoflavone supplements were associated with improvement in reproductive outcomes: increased live births after clomiphene administration (154) or higher endometrial thickness and ongoing pregnancy rates after intrauterine insemination (155) and in vitro fertilization (156). Similarly, dietary soy intake was positively related to the probability of live birth after ART among EARTH study participants (157).

Summary. Meat, fish, and dairy products are often vehicles for delivering environmental contaminants. To date, there is little evidence on the relationship of red meat and white meat to female fertility, and most literature did not disentangle the associations between these foods and environmental contaminants with reproductive outcomes. On the other hand, studies generally suggest that soy appears to have no adverse effects on female fertility, and may be beneficial for ART outcomes. Furthermore, despite concerns regarding environmental contaminants, studies of fish intake and fertility suggest that the benefits of fish consumption may outweigh any risks posed by the environmental contaminants they may carry.

DIETARY PATTERNS

Dietary pattern analysis is an alternate and complementary approach to examine associations between overall diet quality and health outcomes (158).

Dietary Patterns and Reproductive Outcomes

In NHS-II, Chavarro et al. found that higher adherence to a “fertility diet” (consisting of high consumption of monounsaturated fat, vegetable protein, high-fat dairy, low-glycemic carbohydrates, multivitamins, and iron from plants and supplements) was associated with a lower risk of ovulatory infertility (159). Similarly, in a nested case-control study of university graduates in Spain, women with the highest adherence to the Mediterranean diet (characterized by high consumption of fruits and vegetables, fish and poultry, low-fat products, and olive oil) had lower odds of experiencing difficulties getting pregnant (160). Nonetheless, in the NHS-II cohort, adherence to a “fertility” or alternate Mediterranean diet, or to the alternate Healthy Eating Index 2010, was unrelated to risks of SAB (161). On the other hand, a retrospective study reported that higher frequency of fast food and lower frequency of fruit and vegetables intake was related to longer time to pregnancy (162).

Dietary Patterns and ART Outcomes

A favorable role of healthy dietary patterns on ART outcomes has been reported (163–165). In a cohort of 199 Dutch couples, increasing adherence to Dutch dietary recommendations (characterized by high intake of whole grains, fruits, vegetables, monounsaturated or polyunsaturated oils, meat or meat replacers, and fish) before conception was associated with higher probability of ongoing pregnancy (163). In a separate Dutch cohort of 161 couples, Vujkovic et al. found that maternal Mediterranean diet (high intake of vegetables and vegetable oils, fish, and legumes, low snack intake) but not “health conscious/low processed” diet (high intake of fruits, vegetables, legumes, whole grains, and fish, low intake of mayonnaise, snacks, and meat products) was associated with higher probability of pregnancy (164). Given that high intake of vegetable oil was dominant in the Mediterranean diet but not in the “health conscious/low processed” diet, these findings suggest that nutrients in vegetable oil, such as LA, may be responsible for this association. Similarly, in a recent study of young non-obese Greek women, a similar effect of adherence to Mediterranean dietary patterns and ART success was noted (165).

Summary

Although the definition of a healthy dietary pattern slightly varies across studies, these dietary patterns have remarkable overlaps in whole grains, fruits, vegetables, fish (rich in long-chain ω-3 PUA), and olive oil (rich in MUFA), most of which have been shown to improve ART outcomes and chance of pregnancy. Nonetheless, dietary patterns were unrelated to risks of SAB, based on a large prospective study (161).

EMERGING CONCERNS

Foods are vehicles for delivering nutrients as well as nonnutritive constituent chemicals, which could be due to naturally occurring contaminants in the environment or artificially introduced during the processing, packaging, preparing, storage, and transportation of food. Well known examples include mercury in fish, pesticide residues in produce, and growth hormones, antibiotics, and polybrominated diphenyl ethers in meat. Emerging research has suggested that nutrients may interact with the toxicant in affecting specific health outcomes and vice versa. For example, in both human and nonhuman studies, intake of soy food and folates was found to be protective against the adverse reproductive effects of bisphenol-A (166–169). A recent study has shown that the presence of high pesticide residues in fruits and vegetables might modify the beneficial effects of fruits and vegetables on reproductive success (170). Because environmental contaminants are widely dispersed, future studies may need to consider coexposure to environmental contaminants (and mixtures of these contaminants) when investigating the associations between food/nutrients and health outcomes to better form dietary recommendations and guide action for general and susceptible populations.

CONCLUSION

Although much work remains, current evidence has accrued to support that diet could be a modifiable factor for female fecundity. According to existing data, intake of a folic acid supplement before and during pregnancy not only prevents birth defects, but also maintains pregnancy success. On the other hand, despite encouraging data in animal studies, little evidence supports beneficial effects of vitamin D on human fertility. There is considerable evidence suggesting that greater intake of ω-3 PUFA and lower intake of *trans* fats are associated with shorter time to pregnancy and better ART outcomes, whereas the effect from other fatty acids (such as ω-6 PUFA, SFA, and MUFA) on female fecundity is less clear. Furthermore, studies generally suggest that soy appears to have no harm on female fertility, and little data are available to disentangle the relationship of dairy, meat, and fish intake,h environmental contaminants, and reproductive outcomes. Finally, greater adherence to healthy dietary patterns favoring whole grains, fish, fruits, vegetables, and olive oils—most of which are aligned with the 2015–2020 Dietary Guidelines for Americans (171)—may not only improve overall health but boost fecundity. Because most evidence came from observational studies, well designed RCTs are essential to validate these findings, which can be translated into practice and solid recommendations for pregnancy planners.

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