

# Fertility & Nutrition

## A Capstone Project

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## Introduction

Approximately 15% of couples of reproductive age experience infertility in the United States (1), and worldwide the numbers are similar (2). Infertility is defined as the inability to get pregnant after 12 months of unprotected sex or after 6 months for couples where the woman is over 35 (3). In the United States, approximately 12% of women currently have impaired fertility (4). Additionally, over 25% of infertility cases are attributable to the male

partner, underscoring the need to include them in assessment and interventions (5). Infertility is associated with increasing age, gynecologic disorders such as PCOS and endometriosis as well as modifiable nutrition and lifestyle factors (6, 7).

Nearly 150,000 fertility procedures were performed in 2013 (8), and that number is only growing. Fertility is at a national low partially due to delayed pregnancy and other personal choices (8, 9). However, this also means more women will eventually seek fertility counseling in order to achieve pregnancy at later ages.

While the nuances of how diet and lifestyle directly affect fertility are not completely known, more and more details are being illuminated through both observational and experimental studies. Yet, there are very few resources dietitians can access in order to understand this issue fully. This project was created to formulate a central educational asset that dietitians can utilize in order to understand evidence-based nutritional and lifestyle changes that can improve fertility outcomes as well as techniques for working with clients with infertility. An online lecture is available along with a companion manual created for RDs and their patients. This is available for free to dietitians and other healthcare workers through the Women's Health Dietetic Practice Group website.

This will provide a foundation for RDs to use in order to treat patients with infertility diagnoses, improving fertility outcomes. With this lecture, RDs can work in conjunction with fertility doctors and other healthcare practitioners in order to provide evidence-based diet and lifestyle interventions to these patients

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## Process & Target Audience

This project began as a collaboration with Judy Simon, MS, RDN, CD, CHES, FAND. Judy's expertise on the topic of fertility and nutrition is unparalleled in the field. She is sought after throughout the country. Yet, few dietitians have substantial knowledge of this subject area. Therefore, we identified a need for an educational tool for other dietitians to use in order to gain a basic understanding of evidence-based nutrition practices for fertility. This tool would exist online and be accessible to registered dietitians and other healthcare workers for free.

The Women's Health DPG (WHDPG) was identified as a logical partner for this endeavor, as they have provided a basic webinar on the topic to their members. Their mission is to "Empower members to be the most valued source of nutrition expertise in women's health throughout the lifespan." In particular, they target stages of life specific to women, including preconception. This project is directly in line with these goals, allowing members to provide high quality nutrition expertise on fertility. In addition, the educational tool will allow for dietitians to get continuing education credit through the Academy of Nutrition and Dietetics (AND), as it constitutes additional education on a topic important to many patients.

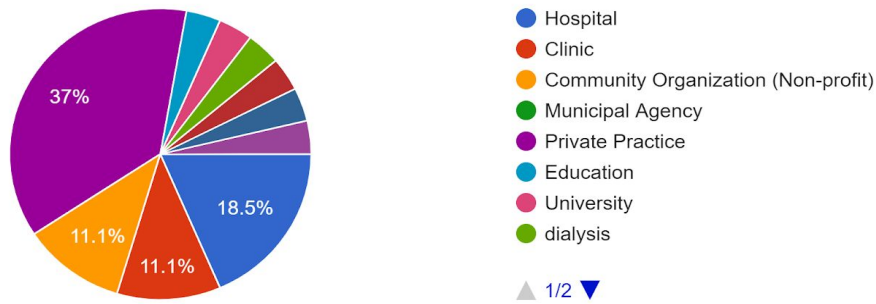
The Women's Health DPG requires a project proposal, which outlines the project and evidence-based information on the topic. This application is available as appendix I. Once that was approved, a survey was created and went out to the members of the

Women’s Health DPG assessing the need for this educational tool and specific topics that might be of interest. Results of this survey are included below:

**Survey Results:**

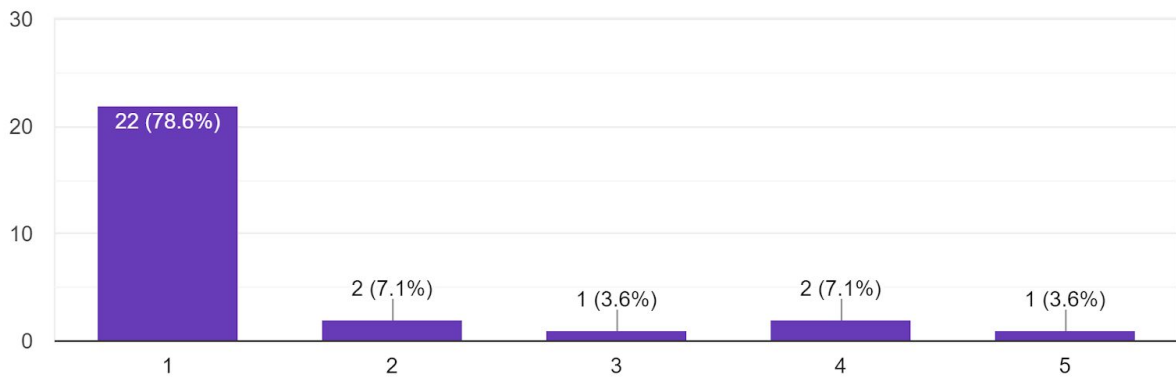
**Dietetic Practice Setting**

27 responses



**I am interested in an online educational module about nutrition for fertility?**

28 responses



**1: Strongly Agree**

**5: Strongly Disagree**

**Please Explain Your Answer (highlights):**

“I am an RD working for an MFM/OBGYN practice -- and see women for pre-conception, especially IVF preconception counselling.”

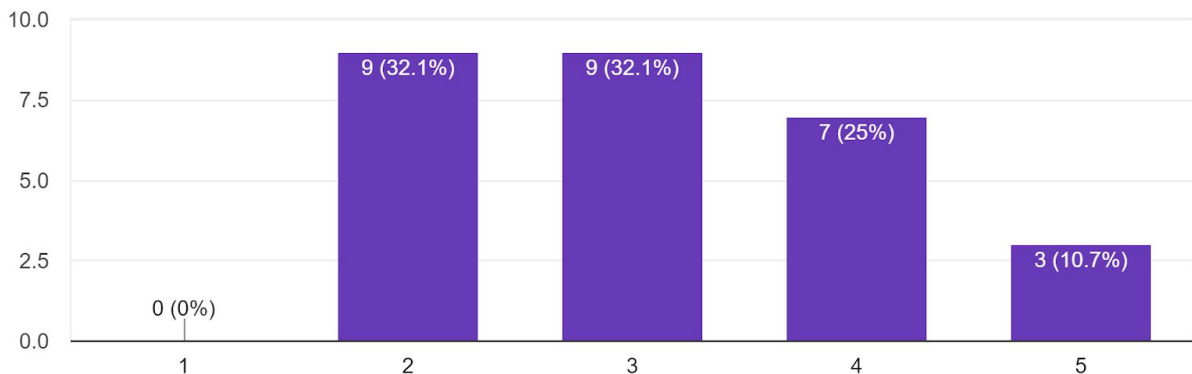
“ I work with women's with PCOS and am always looking for ways to improve my expertise in the area that is challenging for this population.”

“There is so much to learn and read, it would be great to have it all in one place”

“This would be a new area of study much needed for RDNs”

## How confident are you in your knowledge on the topic of nutrition and fertility?

28 responses

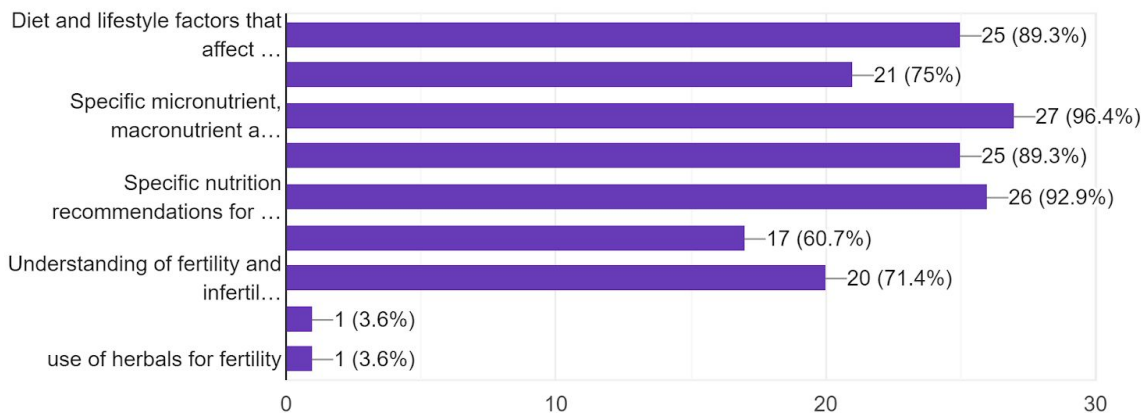


**1: Strongly Agree**

**5: Strongly Disagree**

## What topics are most relevant to you? Please check all that apply.

28 responses



68% of responded preferred a powerpoint or lecture based format. 21% had viewed some sort of fertility and nutrition webinar or continuing education presentation in the past. Of these, most were from Today’s Dietitian or from the Women’s Health DPG. Given these results, a video presentation format using Panopto was decided upon. It was also

decided that the presentation would provide specific information about nutrition interventions for fertility using the nutrition care process as a framework.

## Nutrition Issue of Focus

While it is difficult to attribute a particular percentage of infertility cases to lifestyle factors, diet, exercise and weight, they are widely accepted to contribute to fertility outcomes and assisted reproduction technology (ART) outcomes (1, 2). Several medical conditions related to infertility are known to be associated with lifestyle parameters, including PCOS, endometriosis, obesity and hypothalamic amenorrhea (1). Many studies (discussed below) have also explored how micronutrients, macronutrients and dietary patterns contribute to risk for infertility as well as their relationship to conception and live birth. However, traditional approaches to infertility usually include costly medical interventions and procedures before lifestyle interventions are considered (3, 4). Yet, certain conditions are known to merit lifestyle interventions as a first line of defense, such as PCOS (5).

There is very little information on the nutrition care process for infertility provided by the Academy of Nutrition and Dietetics (AND) Nutrition Care Manual (NCM). For conditions such as PCOS, the NCM recommends that patients who are obese follow the same weight loss recommendations as other obese patients (6). The WHDPG, however, has provided a webinar on the topic previously. Other than this, there are few educational resources for dietitians to follow in order to provide medical nutrition therapy to infertility patients. A need for a more structured nutrition care process for this common issue is apparent.

The American College of Obstetricians and Gynecologists (ACOG), an association of physicians specializing in women's health, provides information for patients who may have infertility. They recommend visiting an obstetrician-gynecologist, a urologist (if you're male), or a reproductive endocrinologist if a specialist is needed (7). The tests listed below under "Tests of Fertility" are generally administered. ACOG acknowledges that diet and lifestyle may play a role in infertility. They mention in particular that overweight, underweight and over exercise can affect female fertility, and alcohol can affect male fertility on their website. Clearly, there is a role for registered dietitians to play here. However, they are not mentioned specifically on the ACOG website, but rather an emphasis is placed on hormonal, surgical and other medical treatments.

Similarly, the American Society for Reproductive Medicine (ASRM), an organization which was designed to be the leader in information, education and standards for reproductive medicine, recommends medical treatment through drugs or surgery (4). Otherwise, they recommend IVF or other ART treatments. However, they have recently developed a special interest group called NutriSig for members who are interested in

nutrition and fertility. Yet, there are few dietitians involved. This is not surprising given the focus of their organization, but more collaboration between disciplines and diet and lifestyle resources are needed for these patients.

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## Methods of Investigation

Research was conducted using the PubMed database primarily supplemented with Google Scholar and some Google searches. Many articles were also provided by collaborators. Judy simon provided article titles for several of the articles used, as did Hillary Wright. The ASRM website was used for information on fertility testing and treatment. The Nutrition Care Manual was used for information on nutrition diagnoses, monitoring and evaluation. Research was conducted over a period of several months from July, 2018 to March, 2019. Articles were generally of a high quality (see appendix II for evidence analyses of three main articles used) and published in peer reviewed journals. A partnership was formed with the Women’s Health DPG as described above. They agreed to provide a platform for the presentation and help promote it. See agreement in appendix III.

### **Search Terms:**

#### **Nutrition:**

Fertility and nutrition

Infertility and nutrition

Diet and infertility/fertility

Lifestyle and infertility/fertility

Micronutrients and fertility/infertility  
Vitamins and fertility/infertility  
Dietary Patterns and fertility/infertility  
Dietary patterns and IVF outcomes  
Nutrition and IVF outcomes  
Mediterranean diet and fertility/infertility  
Foods and infertility/fertility  
Supplements and infertility/fertility  
Macronutrients and infertility/fertility  
Dietary fat and infertility/fertility  
Dietary protein and infertility/fertility  
Carbohydrates and infertility/fertility

**Conditions:**

Obesity and infertility/fertility  
Overweight and infertility/fertility  
Age and fertility/infertility  
Polycystic Ovary Syndrome and fertility/infertility  
Endometriosis and fertility/infertility  
Hypothalamic amenorrhea and fertility/infertility  
Hypo/hyperthyroidism and infertility/fertility  
Menstrual cycle length disorders  
Tests of infertility  
Treatment of infertility  
Diminished ovarian reserve

**Reviewers**

In order to qualify for continuing education credit, an educational module must be reviewed by three experts in the field. Judy Simon provided introductions to two registered dietitians currently practicing fertility nutrition - Rachelle Mallik and Hillary Wright. Rachelle worked for Weill Cornell Center for Reproductive Medicine and Infertility and now owns her own fertility focused nutrition business. Hillary Wright is the Director of Nutrition Counseling for the Domar Center for Mind Body Health and a Senior Nutritionist at the Dana Faber Cancer Institute. She specializes in women's health.

The Women's Health DPG agreed to provide a third expert reviewer - Lauren Manaker, who owns her own fertility-focused nutrition practice and has written an e-book on male fertility. Each reviewer examined the presentation and provided electronic comments, which were then incorporated into the final presentation before filming it.



A sound room at the University of Washington's Odegaard Hall was reserved in order to film the presentation using Panopto software. The video was then made available to the WHDPG for continuing education for its members.

## Evidence Analyses Summary

### *Nutrition Assessment of Infertility Patients*

In order to assess a patient who has been diagnosed with infertility by a reproductive specialist or other medical provider, medical history must be provided. One must verify an infertility diagnosis and any attributed causes in order to understand relevant nutritional interventions. A 24 to 48 hour recall is also a useful tool for assessing diet quality and adherence to a diet that is conducive to fertility, as outlined in the intervention section. Labs may also be relevant as discussed under Fertility Tests. Follicle stimulating hormone, anti-mullerian hormone, androgens, blood glucose and other labs may be relevant for measuring the severity of the conditions discussed below. Lastly, physical findings are often useful in assessing fertility-related conditions such as PCOS, obesity and hypothalamic amenorrhea all discussed below. These items should be noted and used later for follow-up and as measurements of success. Of course, for couples with infertility, the ultimate measure of success is viable pregnancy. However, this is not always achievable only through diet and lifestyle intervention and working together with a reproductive team is often advisable.

### **Obesity's Complex Relationship with Fertility**

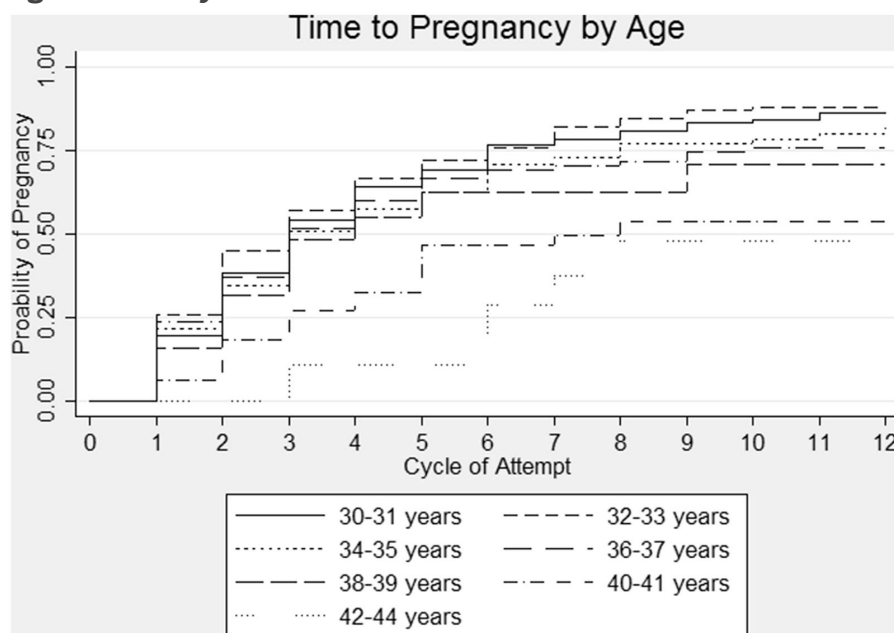
As with any patient, dietitians will want to assess BMI and physical characteristics. Obesity can have significant effects on fertility, though this does not mean that obese couples cannot achieve pregnancy through diet and lifestyle changes with or without assisted reproductive technology (ART). It has been shown in studies that obese women are more likely to have irregular menses (1). This is believed to be due to hormonal changes induced by excess adipose tissue, which causes increases in insulin resistance and insulin secretion as well as adipose aromatase, which produces excess estrogen (1). In one cross sectional study of 120 obese women, those over 175% of ideal body weight were found to be more likely to have menstrual irregularity than women below 150% of IBW (54% compared to 19%) (2). Women who are obese are also more likely to be anovulatory and have anovulatory infertility (1). It has been found that women of a BMI greater than 27 have a relative risk of anovulatory infertility of 3.1 compared to women with a normal range BMI. In this population, weight loss may help to restore ovulation and ability to achieve pregnancy (1).

Obese women also require higher doses of medications used to induce ovulation with generally less successful results (1). However, studies have been contradictory as to whether BMI affects in vitro fertilization (IVF) and other ART outcomes. Some have shown no relationship at all (3, 4). However a systematic review from 2011 found that

both overweight and obese women were less likely to achieve clinical pregnancy through IVF and intracytoplasmic sperm injection (ICSI) and more likely to have a miscarriage (5). A recent systematic review of weight loss interventions in order to improve fertility in men and women who are overweight and obese concluded that certain interventions do improve pregnancy rates (6). Specifically, Best et al. found that reduced calorie diets and exercise interventions for women were more likely than control interventions to result in pregnancy with a risk ratio of 1.59 for pregnancy. However, the confidence interval was 1.01 to 2.50. There are also mixed study results on obesity and miscarriage (1). Obesity's effects on fertility are multifactorial and are related to oocyte quality, follicular recruitment and ovulation as well as fertilization and embryo development in addition to negative effects on the endometrium (6). Knowing this, it makes sense to counsel women who are overweight or obese and experiencing hormonal disturbances or anovulation on weight loss techniques and physical activity. However, it's important to take into account that these techniques have limitations.

Obesity may also affect male fertility. Specifically, men with obesity have an increased risk of oligozoospermia and asthenozoospermia in some studies (7). Plus, central adiposity is linked with reduced sperm count, concentration and motility (7). Other measurements of associations between male fertility and obesity have mixed evidence. Hormonally, obesity may reduce availability of testosterone and increase androgen availability, also possibly contributing to lowered fertility. Therefore, it is important to counsel male patients about diet and lifestyle changes that may reduce BMI as well.

### Age & Fertility

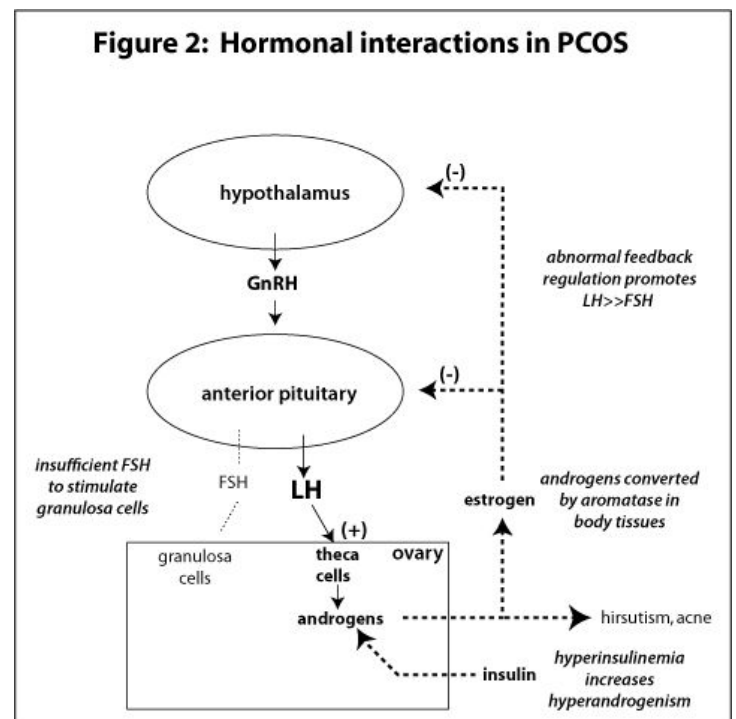
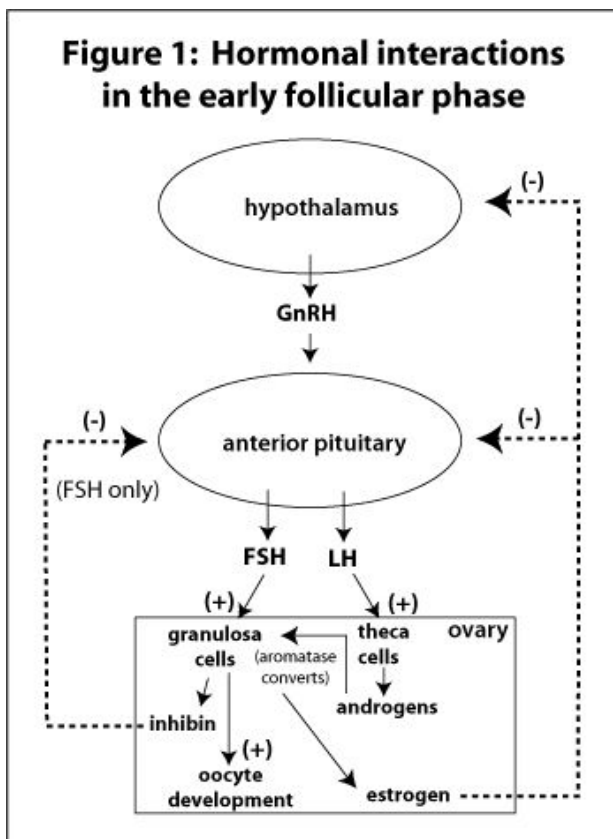


(Figure 1: 8)

When working with infertility patients it is important to keep in mind that age is an independent effector when it comes to fecundity (8). A cohort study of older women attempting to get pregnant through natural means found that while the median time to pregnancy for women under 38 was 3 months, that time increased for every year increase in age, with women 38-39 years of age having an average 4 month time to pregnancy and women 40-41 having an average 8 months time to pregnancy. In addition, after 40, the average time to pregnancy was greater than 1 year (8). Reduction in fecundability began at age 34 with a 14% decrease compared to women age 30-31, 19% decrease age 36-37, 30% decrease in women 38-39 and 53% decrease in women 40-41 (8). This doesn't mean it's impossible to get pregnant at ages over 40, but the likelihood of successful pregnancy does go down, and it can be important to discuss this with patients, as diet and lifestyle changes can only go so far.

### Polycystic Ovarian Syndrome (PCOS) & Fertility

PCOS is a common syndrome, affecting approximately 5-10% of women (9). PCOS is a variable syndrome that often includes oligo-ovulation or anovulation, hyperandrogenism and the presence of polycystic ovaries. According to the Rotterdam criteria, the syndrome must include 2 of the these 3 symptoms (10). These were reaffirmed in recent guidelines published by Monash University (11). It was also emphasized that ultrasound is not a necessary diagnostic tool for the syndrome. Common symptoms include hirsutism, alopecia, acne, menstrual irregularity, insulin resistance and a greater risk for several chronic diseases (9,10,11).



(Figure 2: 12) Approximately 80% of women with anovulatory infertility also have PCOS (9). Elevated luteinizing hormone and hyperandrogenism can affect ovulation. Premature granulosa cell luteinization can occur due to hyperinsulinemia and hyperandrogenism (13). It is also possible that oocyte maturation is impaired by the growth factor dysregulation. While women with PCOS are more likely to have infertility, they are not necessarily less able to have a successful pregnancy, as studies have shown that over a lifetime, women with PCOS tend to have the same number of successful parity as women without it (14, 15). However, careful management of the syndrome is needed in order to achieve pregnancy.

First line treatment of PCOS is lifestyle related. The ASRM recommends a hypocaloric, low glycemic load diet and increased physical activity (16). Many women with PCOS are given drug therapy to induce ovulation. Letrozole and Clomiphene citrate are common interventions that patients may be prescribed in order to induce ovulation (9). Letrozole works by inhibiting estrogen synthesis. Metformin may also improve ovulation, while helping with insulin resistance (10). If these do not work, gonadotropins are second line therapy for ovulation induction (10). Ultimately, IVF may be required to achieve pregnancy if these other therapies fail for PCOS patients. Specific nutrition interventions for PCOS are discussed below under “Interventions”.

### **Endometriosis and Fertility**

Endometriosis is another common cause of infertility, affecting somewhere between 20 and 50% of subfertile women (17). It is a condition wherein the endometrial tissue adheres to areas outside the uterus, such as the pelvic peritoneum. It ranges in severity and can cause painful periods and infertility as well as inflammation. Diagnosis is done through laparoscopy and examination of lesions. The main theory behind pathogenesis is the reverse flow of menstrual flux through the fallopian tubes including endometrial fragments, which then implants in tissue, causing a chronic inflammatory state (17, 18). There are many theories as to how this connects to infertility. However, no one mechanism is agreed upon. In certain cases infertility is caused by actual occlusions, which prevent sperm implantation, but this is the exception. Other causes are multifactorial (17).

Treatment can include drug therapy, mostly through hormonal drugs that either prevent ovulation or stimulate it. Neither of these has proven consistently effective in eventually inducing fertility. Surgery has also had mixed results (17). However, ART seems effective in aiding to achieve pregnancy. IUI and IVF can both be effective and may be considered for a population with endometriosis, though the condition can affect success rate (19). There are a few specific dietary recommendations for those with endometriosis that can help to mitigate inflammation discussed below under “Interventions”.

### **Hypothalamic Amenorrhea and Infertility**

While there are few systematic reviews on the topic, another common cause of infertility is secondary amenorrhea. The absence of menses after menarche or secondary amenorrhea can be explained by many different circumstances (20). However, the majority of cases of secondary amenorrhea are related to PCOS, hypothalamic amenorrhea, hyperprolactinemia or ovarian failure. Hypothalamic amenorrhea is the most common form and often occurs in conjunction with psychological stress, over exercise, undernutrition, lack of available energy or severe weight changes (20). Long-distance running and other endurance athletes are particularly vulnerable (21). However, it should be noted that not all patients have underweight BMIs. This condition causes infertility due to a hormone cascade that leads to very low estrogen levels, thus causing lack of ovulation and endometrial thickening, making it impossible to become pregnant (22). Prolongment of this condition can cause long-term atrophy of the uterus and related organs (22).

There are a few RCTs on the treatment of hypothalamic amenorrhea. Small trials have also shown the effectiveness of cognitive behavioral therapy in treatment (23). Hormonal treatments meant to induce ovulation are also used, such as human menopausal gonadotropin and gonadotropin releasing hormone (22). IVF is a recommended option for women with this disorder. However, success rates vary. A recent systematic review of treatment concluded that leptin, dietary interventions and other non-pharmacological interventions are all effective treatments (24). Specific dietary and lifestyle recommendations are included below under "Interventions".

### **Hypothyroidism & Subclinical Hypothyroidism**

Thyroid hormones are an integral part of the process of fertility. Triiodothyronine (T3) works with FSH to stimulate granulosa proliferation and maintenance (25). Thyroxine may also play a direct role in oocyte quality, as oocytes have been found to have receptors for it (26). Thyroid hormones may also affect sperm quality (26). In women, hyperthyroidism tends to cause hypomenorrhea and polymenorrhea, while hypothyroidism can be associated oligomenorrhea and amenorrhea (26). It is estimated that 20% of infertile women have thyroid disease. Hypothyroidism may also be associated with a thin endometrium (26). The affiliated menstrual irregularities can affect fertility and should be addressed in patients attempting to get pregnant. If your patient has thyroid disease, be sure they are seeing an endocrinologist to address these issues.

There is limited evidence that subclinical hypothyroidism or hypothyroidism that doesn't meet the current cut off of 5 mIU/L of thyroid stimulating hormone (TSH), but is still higher than 2.5 mIU/L may affect fertility outcomes (27). According to an ASRM systematic review on the topic, some studies have shown an affiliation between subclinical hypothyroidism and ovulatory dysfunction. However, there is a lack of consistency in the definition of subclinical hypothyroidism and the methodology of

these studies. Similarly, there is mixed evidence that thyroid antibodies indicating mild thyroid autoimmunity are associated with infertility. However, some studies show that treatment with Levothyroxine may improve pregnancy outcomes (28).

### Fertility Tests

Tests of biochemical and physiological causes of infertility are indicated after 12 or more months of regular unprotected intercourse without successful pregnancy (29) or after 6 months when the female partner is over 35 years old (30). At most stages of infertility diet and lifestyle changes can be beneficial. However, it is important to work together with a team of reproductive specialists if patients qualify as infertile.

Test (29)	Biological Significance	Interpretation/Relevance
<i>Tests of Ovarian Reserve</i>	Measure of quality and quantity of oocytes ultimately indicating fecundity	Gives information to clinicians to guide counseling of planning for pregnancy. Often used by reproductive clinicians in deciding which form of ART to pursue.
Antimullerian Hormone & inhibin B	Glycoprotein hormones produced by small ovarian follicles. AMH is secreted by primary, preantral and antral follicles. Inhibin B is secreted by antral preantral follicles.	Direct measures of quantity of number of follicles. Decline with age.
Follicle Stimulating Hormone (FSH)	A drop in inhibin B causes less negative feedback, which increases FSH secretion	Indirect measure of oocyte quantity
Estradiol	Increases in FSH earlier in a woman's cycle will accelerate new follicular growth and increase estradiol. This eventually results in a shorter cycle.	Used in conjunction with other tests to determine ovarian reserve.
Antral follicle count	Number of follicles with 2-10 mm diameters. Test done during the early follicular phase via ultrasonographic transvaginal scan.	Numbers are indicative of the size of the follicular pool and eggs available for retrieval.
Ovarian Volume	Ultrasound of size of ovaries	Declines with age and can correspond to ovarian reserve.

Hysterosalpingogram	Dye is injected in the uterus and cervix, while x-ray imagery is taken of its course through the uterus into the fallopian tubes	Indicates if there are structural abnormalities or tubal occlusions.
<b>Tests of Male Fertility</b>		
Tests of Semen Analyses (31)		
Semen concentration and volume	Measures of the quantity and density of sperm	Low volume can suggest potential retrograde ejaculation, ejaculatory duct obstruction, hypogonadism or other structural issues. Azoospermia (absence of sperm) or oligozoospermia (low sperm concentration) can indicate retrograde ejaculation when coupled with the presence of sperm in post-ejaculatory urinalysis.
Sperm motility and morphology	Measures of sperm structure and movement	Can help diagnose infertility and subfertility in men based on relative measures in the population.
Sperm DNA tests and anti-sperm antibody tests	Tests of genetic factors and potential autoimmune factors in sperm	Can help predict whether ART will be effective.
Transrectal Ultrasonography	Sonogram of seminal vesicles	Can help to diagnose obstructions.

Ovarian reserve is a test of oocyte quality and or quantity that is measured both through biochemical tests and an ultrasound of the ovaries (29). The biochemical tests include measurement of follicle-stimulating hormone (FSH), anti-mullerian hormone (AMH), estradiol and inhibin B. Inhibin B and AMH are secreted by small ovarian follicles, so their levels are a direct reflection of the number of ovarian follicles remaining. Decreased inhibin B will increase the amount of FSH secreted by the pituitary gland, which will increase estradiol production and ends up shortening the length of a cycle over time (29). Fertility patients should have had a test of FSH and Estradiol together, as varying levels of these hormones distinguish between thyroid disorders and ovarian disorders (30).

Antral follicular count (AFC) and ovarian volume are measures of egg number and quality and assessed through ultrasound. The AFC is indicative of the overall follicular reserve and correlates to the number of oocytes that can be retrieved during ART (29). Ovarian volume decreases with age and can be indicative of ovarian reserve (29).

According to the ASRM, ovarian reserve should be used as a screening test rather than a definitive diagnosis - giving doctors an idea of which patients are at risk for diminished ovarian reserve and ultimately are less likely to get pregnant via ART. Of these tests AMH likely has the most potential to be used for screening for poor ovarian response to ART, and there is fair evidence that AFC may be useful in this regard as well, but all of these tests should not be combined as some are highly correlated. Diminished ovarian reserve is distinct from menopause and only applies to women of reproductive age. It indicates that a woman will have lower response to ovarian stimulation and is less likely to conceive naturally or with ART (29). However, it does not mean it will be impossible to get pregnant.

Another test that may be performed is a hysterosalpingogram. This is a test wherein dye is injected in the uterus and cervix, while x-ray imagery is taken of its course through the uterus into the fallopian tubes (29). This helps screen for tubal occlusion and any structural abnormalities of the uterus (30).

### **Male Fertility Analysis**

Male factors contribute to the majority of infertility cases (31). When a male partner of a couple with infertility is evaluated, reproductive history, including items such as any major medical conditions or procedures and any exposure to gonadotoxins is recorded. Then, a semen analysis is performed, which includes examination of sperm concentration, motility and morphology (31). These parameters are good indicators of potential for conception and help to categorize men as either infertile or subfertile (31). However, these numbers are not a direct reflection of normal sperm parameters in the general population, as men with semen values outside these ranges may still be fertile and those within normal parameters can still be infertile. If an initial screening is abnormal, specialized tests may be used. These include endocrine testing, post-ejaculatory urinalysis, transrectal ultrasonography or tests on semen such as leukocytes in semen, antisperm antibodies and sperm DNA tests (31).

### ***Nutrition Diagnosis for Infertility***

#### **Common Nutrition Diagnosis for Infertility Patients (32)**



<b>Problem</b>	<b>Etiology</b>	<b>Signs &amp; Symptoms</b>
Excess Carbohydrate Intake	Related to PCOS and insulin resistance	As evidenced by weight gain, insulin levels, glucose levels
Inadequate Caloric Intake	Related to hypothalamic amenorrhea	As evidenced by energy deficit, amenorrhea, TSH levels, failure to meet more than 75% of needs
Inadequate Protein Intake	Related to PCOS or hypothalamic amenorrhea	As evidenced by not meeting more than x% of protein needs (based on weight) or low protein diet, weight loss
Inadequate Iron intake	Related to increased needs due to desire to become pregnant	As evidenced by ferritin level, fatigue, low iron diet
Food and nutrition-related knowledge deficit	Related to infertility	As evidenced by diet not conducive to becoming pregnant (exp: high fast food intake, low fruit and vegetable intake)
Inadequate vitamin intake (vitamin D, Folate, B12 Vitamin E or other related vitamins)	Related to infertility	As evidenced by diet low in vitamin or labs related to vitamin

### *Evidence-based Nutrition Interventions*

#### **Female Partner**

There is no one fertility diet. However, recent research shows that certain dietary patterns may be more conducive to conception either through natural means or through ART (33). In addition, large cohort studies have shown some specific foods to be beneficial for lowering time to pregnancy (TTP), risk of infertility and increasing the likelihood of a successful pregnancy in women.

#### **Mediterranean Diet**

Several recent studies have examined specific dietary patterns and fertility. The Mediterranean diet pattern was associated with lower “difficulty getting pregnant” in a case control study of 485 women in Spain in which a large cohort was asked, “Have you

consulted a physician because of difficulty getting pregnant?” and those who responded “yes” were matched with a variable number of controls (34). A food frequency questionnaire was administered previously to determine adherence to a “Mediterranean type dietary pattern”. In this study those in the highest quartile of adherence had a 22 to 44% lower risk of having difficulty getting pregnant compared to those in the lowest quartile of adherence. Specifically, of the 485 cases examined, 94 were in the highest quartile of adherence, compared with 141 in the lowest quartile ( $P = .002$ ). Those in the highest quartile of adherence had a matched odds ratio for seeking infertility help of .56 when adjusted for animal protein, trans fat and fiber intake. The researchers cited theories that linoleic acid may be an important factor in this diet, as it is a precursor to necessary prostaglandins in the ovulatory cycle as well as those that play a role in endometrial thickening. They also hypothesized that the Mediterranean diet may lower insulin resistance, which could be more conducive to ovulation.

A study in the Netherlands examining 2007 couples undergoing IVF with ICSI also found a positive association between adherence to a Mediterranean type diet and increased fertility. Diet was determined through the examination of FFQ data rather than a verified score (35). However, they compared it with previous Mediterranean diet studies and found good comparability. Mediterranean diet was defined as “high intakes of vegetable oils, vegetables, fruits, nuts, fish, and legumes, low dairy intake, and moderate intake of alcohol,” and high adherence was associated with a 40% increase in probability of clinical pregnancy as well as an increase in serum and follicular fluid folate and B6, compared with those with the lowest adherence to this dietary pattern. These researchers believed that this may have contributed to an increase in fertility due to their relationship with homocysteine build up, which may be related to poor outcomes in ART. Importantly, in order to tease apart effects of a Mediterranean diet and other dietary patterns considered healthful, the researchers in this study also examined a “health conscious, low-processed” dietary pattern with many of the same qualities, except that it featured a different fat profile. This diet pattern was not associated with high intake of linoleic acid or an increase in serum B6 and was not associated with an increase in clinical pregnancy. The researchers largely attribute the benefits to these differences.

Another more recent study which examined the Mediterranean Diet using the verified MedDietScore and IVF outcomes in a cohort of 244 Greek couples with primary infertility found that those in the highest tertile of adherence to the Med diet, as measured by the verified MedDietScore, were 65% more likely to achieve clinical pregnancy and 67% more likely to have a live birth than the lowest tertile of adherence (36). Fully adjusted risk ratios were .29 for clinical pregnancy for the lowest vs. highest tertiles of adherence and .25 for live birth for the lowest vs. highest tertiles of adherence to the MedDietScore. Of those in the highest tertile, 50% achieved clinical pregnancy, compared with 29.1% of those in the lowest tertile of adherence. Similarly, 48.8% of those in the highest tertile achieved live birth vs. 26.6% in the lowest tertile of

adherence. When stratified by age, this benefit only held true for those under 35 years of age.

The CDC pools data from fertility clinics across the United States. For the year 2016 approximately 29% of IVF cycles resulted in live birth (37). This suggests the Mediterranean diet may represent a significant increase in odds of successful birth when used in conjunction with IVF.

Previously, one of the largest studies to examine diet and infertility (N = 17,544) - the Nurse's Health Study II (38), concluded that a diet higher in monounsaturated fats, lower in trans fats, higher in plant-based foods and lower in animal proteins as well as rich in complex carbohydrates, high fat dairy and nonheme iron and multivitamins was associated with a much lower risk of infertility. In this cohort, they found that women in the highest quintile of adherence to what they identified as the "fertility diet" pattern had a relative risk of .34 for ovulatory disorder infertility. The diet was based on previous studies of this large cohort.

## **Specific Foods**

### **Seafood**

There is further evidence that these foods are conducive to increased fertility in a recent study that linked consumption of 8 or more servings of seafood per cycle with lower time to pregnancy and greater sexual activity (39). This was true for both men and women. Specifically, in a cohort of 501 couples, men who consumed 8 or more servings of seafood per cycle had 47% greater fecundity (defined as lower time to pregnancy) than those who consumed 1 or less servings per cycle. Similarly, women who consumed 8 or more servings of seafood per cycle had 60% greater fecundity. When both partners consumed 8 or more servings of seafood per cycle had 21.9% greater sexual intercourse frequency compared to couples who consumed less seafood. In this study, seafood was defined as fish or shellfish.

The researchers wished to address the contradiction that women who are pregnant are often told to avoid fish due to mercury risk. Yet, there are many proposed benefits to fish for fertility, such as increased progesterone levels. These numbers meant that for couples consuming 8 or more servings of seafood per cycle, 81% were pregnant by month 6, while 64% of those consuming less became pregnant in this time period. Similarly, 92% of the 8 or more serving group was pregnant by month 12, whereas 79% of the couples consuming less were. The researchers believed this may have been attributable to the benefits of omega 3 fatty acids, which had previously been shown to lower risk of anovulation and increase progesterone.

### **Fruit & Fast Food**

Higher fruit consumption and lower “fast food” or highly processed food consumption was associated with a shorter TTP and a lower risk of infertility in a retrospective cohort performed on 5628 nulliparous women in 2018 (40). Here fast food was defined as burgers, fried chicken, pizza and hot chips from fast food outlets. Specifically, the researchers found that women consuming greater than or equal to 3 servings of fruit per day had a median TTP .2 - .6 months shorter than those consuming less, and women who consumed no fast food had an average .4 to .9 months shorter TTP than those consuming varying amounts of these foods. In other words, those consuming fruit less than 3 times per month had a time ratio of 1.19 (or 19% increase in median TTP) for pregnancy compared with women consuming fruit 3 or more times per week.

The study also found those consuming less than 3 servings of fruit per day had between a 7 and 29% increase in risk of infertility, and those consuming fast food 4 or more times per week had between 18 and 41% greater risk of infertility. Though it is not specifically enumerated, it is likely the fast foods were high in saturated fat, refined grains, additives and other ingredients associated with poor quality diet. Grieger et al. mention that the saturated fat, sodium and sugar may be detrimental to the quality of oocytes by altering the follicular fluid lipoproteins. The researchers proposed that the antioxidants and phytochemicals in fruit, meanwhile, may impart a benefit on fertility.

Taken together these studies begin to create the foundation of a diet that is conducive to fertility - one that is high in fruits, vegetables, whole grains and unsaturated fats and low in highly processed foods. This provides evidence for these specific recommendations when speaking to fertility patients.

### **Fatty Acids**

To understand this on a macronutrient level, a few studies have examined fatty acid intake and fertility. Both the Nurses’ Health Study II and a more recent study by Wise et al. found that trans fats were associated with lowered fertility. In the Nurses’ Health Study II, trans fats were found to increase risk of ovulatory disorder infertility (38, 41). Wise et al. examined two cohorts - one in North America and one in Denmark and found that trans fats were associated with reduced fecundability or a fecundability ratio of .86 for those with the highest quartile of intake as determined by FFQ vs. the lowest quartile of intake. Fecundability ratio was defined as the ratio of cycle-specific probability of conception comparing exposed women to unexposed women. However, this was only true in the North American cohort. This was likely due to the fact that trans fat intake was very low amongst the Danish cohort, where trans fats have been taken out of the food system.

Similarly, Wise et al. found that low omega 3 fatty acid intake was associated with lower fecundability. Women who consumed the highest quartile of omega 3’s had a fecundability ratio of 1.21 compared to those in the lowest quartile of consumption. However, there was little association in the Danish cohort, presumably due to the fact

that omega 3 consumption was high across the whole cohort and did not vary as much. The authors attributed the potential benefits of omega 3's to their relationship with prostaglandins. Specifically, omega 3s increase progesterone levels, which in turn create a higher prostacyclin to thromboxane ratio, which may increase blood flow. At the same time, trans fats have been associated with inflammation and insulin resistance, which are negatively associated with ovulatory function (41).

A smaller Australian study of overweight women undergoing IVF found a correlation with successful pregnancy and polyunsaturated fat intake, specifically the omega-6 fatty acid linoleic acid (42). In addition, a recent cohort study found that women undergoing ART benefited from higher serum levels of both omega 3 fatty acids and omega 6 fatty acids (43). In a random sample of 100 women undergoing ART, who were participants in the EARTH prospective cohort, higher serum levels of omega 3 fatty acids and omega 6 fatty acids were associated with greater probability of clinical pregnancy and live birth. Moran et al. proposed this may be due to the fact that higher saturated fat in follicular fluid has been inversely associated with number of oocytes, while omega 6 and omega 3 fatty acids have been associated with better embryo morphology.

### **Whole Grains**

Another aspect of a Mediterranean style diet that may be beneficial is consumption of whole grain products. While not many studies have examined this, a study of 273 women undergoing IVF found an association between both implantation and live birth and the highest quartile of whole grain intake (44). Women in the highest quartile of whole grain intake had a 70% implantation rate per cycle, whereas women in the lowest quartile had a 51% implantation rate. Each serving of whole grains per day was associated with a 33% higher odds of implantation. Whole grain intake was also associated with endometrial thickness. This association was attributed to the consumption of the bran portion of the grain. The researchers hypothesized that this was due to antioxidant effects of micronutrients such as phytic acid, vitamin E and selenium as well as the actions of phytoestrogens present in lignans, which may directly increase endometrial thickness. In addition, whole grains may contribute to glucose and insulin regulation, reducing the amount of androgens in the bloodstream.

### **Micronutrients**

A 2017 Harvard review by Gaskins et al. concluded that there is good evidence that Folate may be beneficial for those seeking to achieve pregnancy by reducing risk of infertility and pregnancy loss and increasing positive outcomes of ART (45). This same review found no conclusive evidence for the supplementation of vitamin D, as many studies are contradictory. However, a possible mediating factor is ethnicity, which seems to play a role in whether vitamin D is beneficial in ART. Various cohort studies of vitamin D sufficiency (defined as a serum level over 30 ng/dl) have shown greater success rates for women with higher serum concentrations (46, 47). However, some studies have found no relationship (48). This may be mediated through race, as one

study found vitamin D levels to be predictive of IVF success in non-hispanic whites but not in Asians (49).

There is mixed evidence for most other micronutrients. Vitamin B6 through its work with Folate in the homocysteine pathway, and vitamin C, through its antioxidant effects, may contribute to fertility in women (50). More studies are needed. That said, it is safe and simple to suggest a prenatal vitamin for any patients looking to get pregnant in order to ensure no underlying deficiencies are affecting fertility. Because these vitamins do not have any specific standards, a vitamin with the DRI of folic acid, iron, choline, vitamin D and B6 would be appropriate. The Nurses' Health Study II showed a lower risk of infertility with intake of multivitamins (38) with a RR of .88 to .59 for ovulatory infertility depending on how many vitamins were taken per week compared to women who didn't take any vitamins per week. The researchers attributed this at least in part to the folic acid in the vitamins.

### Other Substances

Gaskins et al. concluded that antioxidants are not proven to be beneficial in supplement form for women. However, in men several studies show some promising results, particularly with regard to sperm quality, as mentioned below (45). Alcohol and caffeine have also been studied extensively in relation to fertility. However, these studies have contradictory conclusions. Most studies have been retrospective and may have been subject to recall bias. Therefore, evidence for the relationship of these substances with fertility outcomes remains insufficient. Moderate intake of caffeine (no more than 2 cups per day) and little to no alcohol due to its teratogenic nature are considered best practices.

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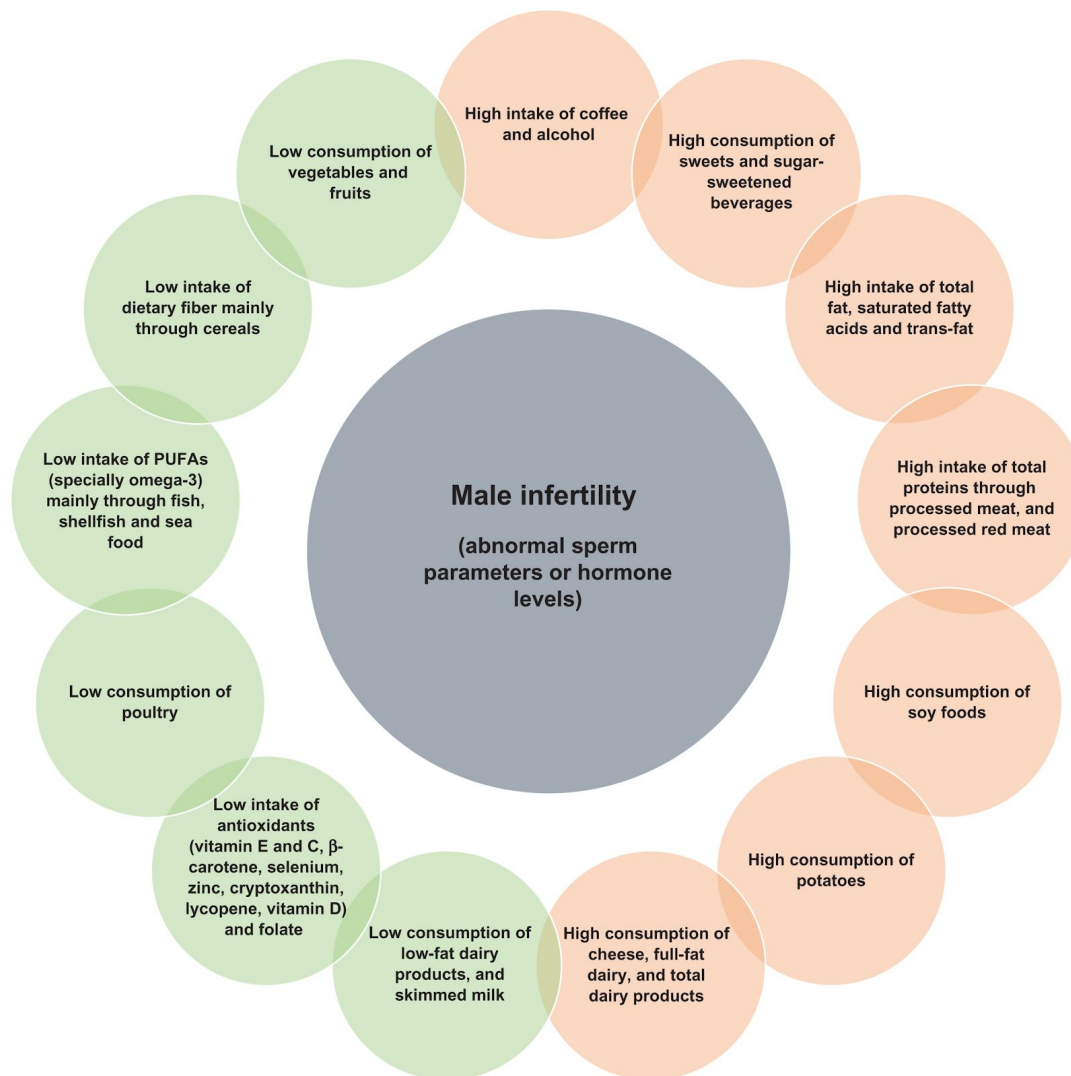
CLINICAL ENDOCRINOLOGISTS, AMERICAN COLLEGE OF ENDOCRINOLOGY, AND ANDROGEN EXCESS AND PCOS SOCIETY DISEASE STATE CLINICAL REVIEW: GUIDE TO THE BEST PRACTICES IN THE EVALUATION AND TREATMENT OF POLYCYSTIC OVARY SYNDROME--PART 1. *Endocrine Practice: Official Journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists*, 21(11), 1291–1300

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## Male Partner



### Food & Macronutrients

Evidence of beneficial and detrimental properties of several common foods exists for men as well. Low fat dairy, fish and fruits and vegetables are in general associated with better sperm outcomes. Whereas, higher fat dairy, processed meat and sweets have been associated with poorer sperm outcomes (1). A systematic review by Salas-Huetos et al. from 2017 found only 35 out of 1940 recent observational studies on nutrition and male fertility to be of high enough quality to include (1). Thus, it is clear that more high quality studies are needed on these topics. Of the studies they examined, several had promising evidence that certain foods are associated with sperm outcomes. In general food with an antioxidant effect or antiinflammatory effect is associated with better sperm outcomes, while food that increases inflammation or oxidative stress is associated with poor sperm outcomes. In addition, foods that are conducive to insulin sensitivity seem to have positive effects on sperm, while those that cause insulin

resistance (i.e. high glycemic index foods) seem to be detrimental. Slals-Huetos et al. largely attribute these benefits to the antioxidant effects of the micronutrients in these foods, such as vitamin C, vitamin E and polyphenols. Antioxidant levels have been previously associated with the production of reactive oxygen species (ROS) in sperm (2), and studies have shown ROS has detrimental effects on sperm (3). In addition folate, which plays an essential role in DNA synthesis is also found in these foods. Similarly, omega 3 fatty acids may help mitigate oxidative stress in sperm.

For example, a case control study showed that men with infertility consumed less non-fat milk, shellfish, tomatoes and lettuce and more yogurt, meat products and potatoes than controls (4). A later study showed infertile men had significantly lower carbohydrate, fiber, and lycopene intake in addition to higher fat and protein (5). In another study, those with less motile sperm or asthenozoospermia consumed less fruit and vegetables, less poultry, non-fat milk and seafood than controls, while consuming more processed meats, dairy and sweets than controls (6). In a cross-sectional study, low fat milk was found to be associated with higher sperm concentration and motility (7). Another study by the same team found fish consumption to be inversely associated with poor sperm morphology (8). However, processed meats were shown to correspond to negative sperm morphology. A Dutch study, which compared a traditional dutch diet, high in meat and potatoes and whole grains and low in sweets with a “health conscious diet” high in fruits, vegetables and whole grains found that both were positively associated with measures of sperm quality (9).

Similarly to females, the Mediterranean dietary pattern has been positively correlated with measures of fertility in men. Higher sperm concentration, total sperm count and sperm motility were positively correlated with adherence to the Mediterranean diet in a cross sectional study of 225 men in 2016 (10). Few studies have looked at established dietary patterns and male fertility, but Gaskins et al. did perform a similar study to their women’s study above, categorizing men as adherent to a “prudent diet” high in fish, chicken, fruits, vegetables, legumes and whole grains or a “Western diet” high in processed meat, refined grains, processed foods, high calorie drinks and sweets. While they found no association between sperm parameters and the Western diet, they did find a positive correlation between adherence to the prudent diet and sperm motility (11).

### **Fats**

Total fat, particularly saturated fat appears to be negatively associated with measures of sperm quality. Whereas, omega 3’s and other PUFAs have consistently been associated with higher quality sperm in studies. Sperm with low motility have been associated with high intake of saturated fats and trans fats as well as higher intake of total fat (6, 12). Total fat intake has also been negatively associated with sperm count and concentration (13). In contrast, omega-3 fats and DHA fats appear to have a protective effect against

asthenozoospermia (12). Omega 3's have also been positively associated with normal sperm morphology (13).

### **Micronutrients**

There is good evidence that antioxidant consumption may be associated with better sperm quality in men (1). This appears to be due to the fact that oxidative stress has detrimental effects on sperm. Vitamin C, vitamin E, vitamin D, zinc, folate and selenium have been shown to be beneficial for sperm quality (6,14). Vitamin C intake has also been associated with total sperm count, concentration and motility (15).

### **Other substances**

No major relationship between fecundability and alcohol consumption has been found in men. However, some compelling evidence has shown that high caffeine consumption may be negatively associated with fecundability (1). Coenzyme Q10 has been shown in two trials to be beneficial for sperm quality, and in one trial to be beneficial for eventual pregnancy (16, 17).

It is worth noting that it is common for patients to question whether they should avoid inorganic foods or exposure to potential endocrine disruptors such as phthalates and other plastics. These substances have been investigated in regard to fertility and may be worth mentioning. Potential resources for dietitians would be the EARTH cohort studies on bisphenol A and phthalates (18, 19).

## **Nutrition Interventions for Specific Conditions**

### **PCOS**

Of all of the conditions related to fertility, PCOS may require the most specific dietary recommendations due to its close association with insulin resistance and obesity. If these are present, a greater emphasis on macronutrient distribution is placed, similarly to the treatment of type II diabetes. The Mediterranean diet can be a useful guideline here, due to its emphasis on healthy fats and whole grains. In addition, a recent study showed that soy may be beneficial as a source of protein for those with PCOS and may help to lower BMI and increase insulin sensitivity, while decreasing male hormones and inflammatory markers (20). Therefore, it may be beneficial to recommend whole foods sources of soy proteins for clients with PCOS.

### **Endometriosis**

For endometriosis, one small trial found that there may be a benefit to a high antioxidant diet to curb the associated oxidative stress (21). In particular, women who partook in a diet high in fruits, vegetables, nuts and seeds, providing high amounts of vitamins A, C and E, had lower oxidative stress blood markers after two months of adherence to the diet. This provides some evidence that a high antioxidant diet may be beneficial to recommend to those with endometriosis. There is also evidence that a diet

rich in less inflammatory foods (fruits, vegetables, omega 3 fatty acids) may help to prevent endometriosis, and more inflammatory foods (red meat, alcohol, trans fats) may increase risk (22).

### **Hypothalamic Amenorrhea**

In the case of hypothalamic amenorrhea, several small trials have been attempted in which energy intake was of particular focus. A systematic review by Kyriakidis et al. found that these showed inconsistent results. Most of these studies increased caloric intake and decreased athletic training in order to restore energy balance. In most cases, more of the intervention groups experienced restored menses than controls or at least had better hormone markers (23). Therefore, dietitians may choose to focus on energy balance with this clientele. However, it is important to note that it can take up to 6 months or more for menses to be restored.

### ***Monitoring & Evaluation of Infertility Patients***

Fertility patients will often require multiple visits to a dietitian in order to continue to monitor any lifestyle changes that have been implemented and whether they have achieved the desired effect. At these intervals, it may be beneficial to retake a 24-48 hour recall to assess whether dietary changes have been implemented. If relevant, continue to track anthropometric measures. Even small amounts of weight loss have been associated with better outcomes. Some labs such as FSH, TSH and blood glucose levels and others can be used to measure success of lifestyle programs. Dietitians should work in conjunction with reproductive specialists to determine the correct goals and labs to monitor. Lastly, physical findings can also be useful in measuring progress. For instance, in the case of hypothalamic amenorrhea - return of normal fat deposits may be a positive sign of decreased physical activity and increased caloric intake.

Notably, many of these interventions take time to implement and have effects. Most of the studies cited herein have taken place over several months. This may mean meeting with a patient multiple times in order to reinforce positive dietary changes and behaviors. During this time, it may be important to work across medical disciplines to coordinate with a patient's reproductive team. If pregnancy does result, dietitians can also play a role in ensuring a healthy pregnancy, along with a patient's obstetrician. Ultimately, working with couples struggling with infertility can be very rewarding and represents a new avenue for dietitians to influence positive outcomes for patients.

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## Executive Summary

Infertility is defined as the inability to become pregnant after 12 months of unprotected sex or six months if you are over 35 years of age (1). Approximately 15% of couples of reproductive age have infertility (2). 35% of these cases are attributable to both male and female partner factors (3). This educational module was created to provide information on nutrition interventions for men and women with infertility in an online format, easily accessible by dietitians and other healthcare practitioners. It was sponsored by the Women's Health DPG and contains specific recommendations for both men and women with infertility in the framework of the nutrition care process as included below:

### **Fertility Nutrition Assessment**

- Medical hx & Lab tests related to fertility
- Full nutrition hx w/recall & supplements (important to review safety)
- Anthropometrics & nutrition focused physical exam

### **Conditions that Affect Fertility**

- Obesity (insulin resistance) & Underweight (hypothalamic amenorrhea) (ASRM #5 & 16 in presi)
- Age - time to pregnancy (TTP) increases significantly after age 37 (4)
- PCOS - can cause infertility through amenorrhea and insulin resistance (5)
- Endometriosis - affects 20% or more of subfertile women (6)
- Thyroid Conditions - Affects cycles & can cause subfertility (7,8,9)
- Diminished Ovarian Reserve - low response to stimulation (10)
- Sperm quality and quantity (11)

### **Fertility Testing**

All fertility tests for women are essentially tests of oocyte quality and quantity (11)

- Anti-mullerian hormone (AMH) - direct measure
- Follicle stimulating hormone (FSH) - indirect measure
- Estrogen - indirect measure
- Antral follicle count - indicates follicular pool
- Ovarian volume - declines with age, corresponds to ovarian reserve
- Hysterosalpingogram (HSG) - visual test for abnormalities or tubal occlusions

Male Fertility Tests are essentially tests of sperm quality and quantity (12)

- Semen concentration and volume
- Sperm motility and morphology
- Sperm DNA and anti-sperm antibody tests
- Transrectal ultrasonography - visual test of functioning

### **Example Nutrition Diagnosis (13)**

Inadequate caloric intake related to amenorrhea as evidenced by weight loss, amenorrhea, TSH levels, failure to meet more than 75% of needs.

### **Nutrition Interventions for Infertility**

**Evidence-based dietary recommendations to improve female fertility outcomes**

- Mediterranean diet - associated with less difficulty getting pregnant, higher clinical pregnancy, better IVF outcomes (14, 15, 16)
- Nurses Health Study “Fertility Diet” - high monounsaturated fat, low trans fat, plant-based, complex carbohydrates & full fat dairy (RR = .34 for infertility) (17)
- Seafood - lower TTP & greater sexual activity (18)
- 3+ servings of fruit/day - lower TTP compared to less (19)
- 0 - 2 times per week fast food consumption - 34 - 41% lower risk of infertility compared to 4+ meals per week (19)
- Whole grains - Each serving of whole grain was associated with a 33% higher odds of implantation (20)
- High omega 3 and low trans fats - higher fecundability ratio (21)
- Folate, Vitamin B6, Multivitamins - associated with better fertility outcomes (22, 23)
- Vitamin D, Alcohol, Caffeine - still some controversy (22)

#### **Evidence-based dietary recommendations to improve male fertility outcomes**

- Increase intake of fruits & veggies, fiber, PUFAs, poultry, antioxidant rich foods, low fat dairy and milk (24)
- Decrease intake of sweets, total fat, trans-fat, processed meats, full-fat dairy, caffeine and alcohol (24)
- Mediterranean diet & “Dutch Diet” associated with better sperm parameters (25)
- Certain antioxidant supplements may increase live birth rate (26)
- Some evidence for coenzyme Q10 and L Carnitine as supplements (27)

#### **Condition Specific Recommendations**

- PCOS- focus on macronutrient balance, physical activity to mitigate insulin resistance. Lifestyle is first line of treatment, soy protein can be helpful (28)
- Endometriosis - anti-inflammatory foods may help (29, 30)
- Hypothalamic Amenorrhea - higher kcal & less exercise can restore menses (31)

#### **Monitoring & Evaluation for Infertility**

- Reassess nutrition intake, PA, anthropometrics & nutrition focused physical exam every 4-6 weeks
- Multiple individual consults and group nutrition education can be beneficial
- Labs: FSH, LH, TSH & blood glucose
- Consider HAES, mindful eating approach
- Work with the whole reproductive team

The module is available online for continuing education credit through the Women’s Health DPG website.

## **Dissemination, Evaluation & Next Steps**

This lecture will primarily be disseminated through the Women’s Health DPG. They have agreed to place a link on their website and promote it to their membership through their newsletter and other channels. Because this lecture will live on the web and available to healthcare professionals and students, we will also promote it by reaching out to the Academy of Nutrition and Dietetics (AND) and asking them to promote it through their

newsletter and social media channels. In addition, the lecture will be promoted through the following venues:

- Personal social media & website of both student and preceptor
- Sharing with nutrition students at the University of Washington
- Continuing education websites
- UW public health channels (Right as Rain or other)

The educational module will be evaluated through a follow-up survey that will be linked to at the end of the presentation. The questions will line up with the survey given to the women's health DPG to see before and after changes. The survey will detail whether viewers believe they have learned basic information about fertility and nutrition and feel equipped to work with patients in this realm in the future. The survey is attached in appendix IV. Specifically, it will address the learning objectives outlined in the presentation:

- Identify hormones and conditions related to infertility and recognize their relevance to the nutrition care process.
- Classify clinical fertility tests and their significance to dietitians.
- Define and apply evidence-based nutrition assessment, diagnosis, intervention, monitoring and evaluation techniques for women and their male partners diagnosed with infertility.
- Describe which micronutrients, macronutrients and dietary patterns can improve fertility outcomes.
- Apply specific recommendations for the infertility-related conditions.

In order to remain relevant, this information will need to be updated periodically and incorporated more into curriculums. Infertility must be treated like other chronic diseases and included in coursework that addresses common chronic illnesses through the medical nutrition therapy. In addition, the Nutrition Care Manual currently does not address fertility extensively. This information should be incorporated into the manual as a framework for the nutrition care process for infertility, as it was developed with rigorous evidence review and evaluated by several leading RDs in the field of nutrition and fertility.

Personally, I plan to incorporate this expertise into my own practice when I become a registered dietitian. I will specifically seek out patients looking to address these issues and work through the nutrition care process as outlined in the presentation with them. If more dietitians are educated in this area, it may eventually be possible to incorporate diet and lifestyle interventions into healthcare practices specializing in women's health and fertility, allowing for a more integrated approach to fertility treatment. This could represent an alternative form of treatment that allows some couples with infertility to conceive naturally and others to improve ART outcomes.

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## Appendix I

### WHDPG application

[https://docs.google.com/document/d/1j\\_IPcx\\_1XU9GwsB-HQ-64oWjkuxRkW-9XhKpROxVS0k/edit?usp=sharing](https://docs.google.com/document/d/1j_IPcx_1XU9GwsB-HQ-64oWjkuxRkW-9XhKpROxVS0k/edit?usp=sharing)

## Appendix II

### Evidence Analysis Examples

[https://drive.google.com/file/d/11zIV0P1NahHLc0SF075xMU1qYr4\\_VyNg/view?usp=sharing](https://drive.google.com/file/d/11zIV0P1NahHLc0SF075xMU1qYr4_VyNg/view?usp=sharing)

<https://docs.google.com/document/d/1wG-WIaWAmF1KS1eKJUoMcHL5iUeZaCZh5RqNc0YlIk/edit?usp=sharing>

[https://docs.google.com/document/d/1swfLGlWbKWPjQOFbJQ10\\_zMAjyOILqmtCqaXfzsF05g/edit?usp=sharing](https://docs.google.com/document/d/1swfLGlWbKWPjQOFbJQ10_zMAjyOILqmtCqaXfzsF05g/edit?usp=sharing)

## Appendix III

### WH DPG Agreement

<https://drive.google.com/file/d/1FJp-QOMW6U-B6L81QqhNMzfgBfVDS4sI/view?usp=sharing>

## Appendix IV

### Post course quiz

<https://forms.gle/GhMcHNSYRhQJzVsL6>