

Module 3 – Optimising egg health

Learning Objectives:

At the end of this module you should be able to:

1. Understand how diet impacts egg quality
2. Have a grasp on the literature on how nutrition impacts ovarian reserve
3. Have a basic understanding of how 'egg freezing' works

Preparation of an egg

Inside a woman's ovary are hundreds of thousands of follicles. Most of these follicles will contain an oocyte (an immature egg).

During a healthy menstrual cycle, some of the follicles will begin to grow – and the oocytes inside them will develop too. One follicle (called the 'dominant follicle') will break ahead and grow much faster than all the others. Various hormones will inform the ovary that it's time to release an oocyte, and the oocyte will complete its maturing through a process called meiosis. The oocyte, now called an egg (or ovum) will leave the follicle and travel down the fallopian tube (hopefully towards a sperm).

The female egg contributes 23 chromosomes to an embryo (zygote) to create new life. Consequently, a healthy egg is essential for a healthy pregnancy.

Egg quality

Environmental factors impacting egg health

Oxidative stress caused by ageing, pollution, obesity, smoking, alcohol and psychological stress significantly impacts upon egg health.¹ Age is the number one factor affecting fertility. As a woman ages, an increased percentage of eggs contain genetic abnormalities. Older eggs are more likely to accumulate errors in their DNA as they undergo meiosis. Once an egg's DNA is degraded, it can't be healed... the egg is unable to be fertilized – even with Artificial Reproduction Techniques (ART) such as IVF.

A study by Ruebel, L.M. et al. found that overweight or obese women undergoing fertility treatment had abnormally high levels of fat and inflammation in the fluid surrounding their eggs, compared to women of a normal weight undergoing fertility treatment.² Additionally, eggs from the overweight or obese women were found to have 'disorganised' DNA (ie. Chromosomal damage).

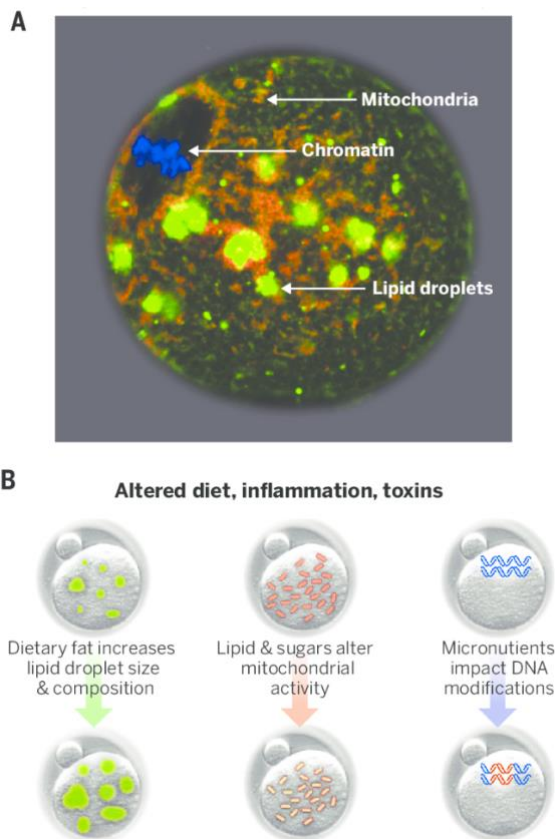


Figure 1: How diet impacts oocyte health. Maternal nutrition affects oocyte provisioning. (A) The maternal environment influences oocyte stores of mitochondria and metabolites. Lipid droplets are stained green with BODIPY 493/503 in a mouse oocyte, and mitochondria are stained with MitoTracker Orange. Chromosomal DNA aligned at metaphase II is stained blue with Hoescht dye. (B) Cytoplasmic constituents respond to maternal nutrition and in turn alter conceptus development.³

Key dietary factors impacting egg health

When it comes to minimising oxidative stress to optimise egg health, emerging evidence suggests that these nutrients play a key role:

Advanced glycation end-products (AGEs) - AGEs are toxic end-products that induce oxidative stress and accumulate with age owing to increased circulating glucose and/or ingestion of foods cooked at high heat (e.g., grilling, barbecuing). Elevated levels in serum and follicular fluid have been associated with a reduced ovarian response and a reduced chance of pregnancy.⁴ Boiling, microwaving, and poaching are better cooking methods to avoid overheating of foods.

Antioxidants - An obvious way to counteract the adverse effects of oxidative stress is to increase antioxidant intake, which may in part explain benefits of the 'Mediterranean diet'.

Omega 3 to omega 6 ratio - One interesting study points to the role that omega-3s can play in improving egg quality with lifelong consumption of a diet rich in omega-3 fatty acids prolonging reproductive function into advanced maternal age, while a diet rich in omega-6 fatty acids was associated with poor reproductive success at advanced maternal age.⁵ This gives some indication as to the benefit of a Mediterranean-style diet for optimising fertility.

Zinc - Emerging research is also pointing the key role that optimal levels of zinc play in making a healthy egg.⁶ Working with mice, scientists discovered the oocyte becomes ravenous for zinc and acquires a 50 percent increase in the metal in order to reach full maturity before becoming fertilized. The flood of zinc appears to flip a switch so the egg can progress through the final stages of meiosis.

Coenzyme Q10 – Use of supplemental coenzyme Q10 is increasing, particularly for older women who want to preserve egg quality. Emerging research suggests that CoQ10 suppresses the aging-induced oxidative stress by reducing the levels of superoxide and DNA damage. A mouse study by Zhang et al concluded that CoQ10 supplementation is a feasible and effective way to prevent postovulatory aging and preserve the oocyte quality.⁷

When it comes to optimising egg quality, it is recommended that nutrition is enhanced for at least one month, prior to egg collection/conception. We'll discuss dietary factors and nutritional supplements in more detail in later modules.

Egg quantity

A woman is born with about one million oocytes – the maximum number of egg cells she will ever have in her life. By the time she hits puberty, that number drops to around 300,000. From those 300,000 only about 300-400 oocytes will turn into eggs through the process of ovulation. As time goes on, fewer oocytes remain, contributing to a woman's declining fertility as she ages.

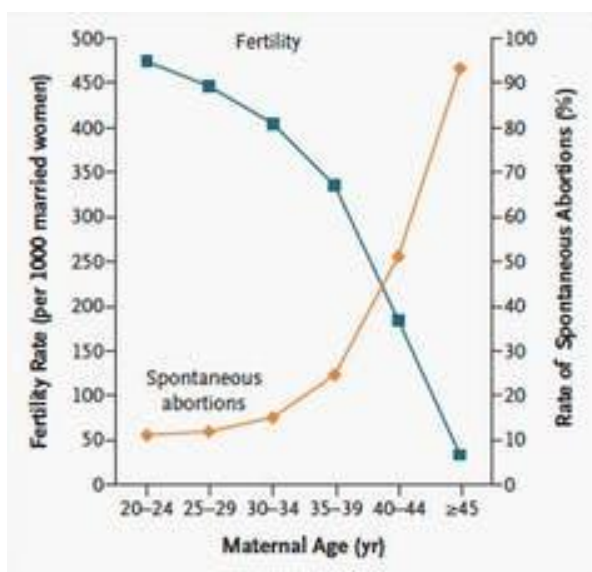


Figure 2: Fertility rates. As women age their likelihood of natural conception decreases whilst rates of miscarriage increase. Both of these phenomena are primarily due to increased rates of chromosomal abnormalities in the egg.⁸

FSH Levels

There are a few tests a woman can undergo to determine if she has any medical conditions such as pre-menopause or if she has a low supply of oocytes. The first is a Follicle Stimulating Hormone (FSH) test, which is a simple blood test conducted on the third day of a woman's cycle. This test essentially

measures how hard a woman's body has to work to produce a mature oocyte. Abnormal results for this test may indicate a woman's body is going into menopause.

AMH Levels

Another blood test that may be conducted is the Anti-Mullerian Hormone (AMH) test. This test can be done on any day of a woman's cycle and can give doctors an idea of how many oocytes a woman has available. Women with a higher number typically respond better to ovarian stimulation.

AMH is a hormone made by the small follicles in the ovary which have not yet begun to develop into mature eggs. Thus, low AMH indicates a reduced ovarian reserve and thus a decreased level of fertility. Although, you may need to remind stressed clients that they only require one healthy egg to conceive.

Additionally, it's also important to note that clients with polycystic ovarian syndrome (PCOS) may, but not always, have higher than normal egg count and AMH levels.^{9 10}

Primary Ovarian Insufficiency

Primary ovarian insufficiency (POI) occurs when the ovaries no longer produce normal amounts of estrogen or release eggs regularly.¹¹ Women undergoing menopause usually start to experience irregular periods. In about 90 percent of cases, the exact cause of POI is unknown, however common causes may include:

- Genetic disorders such as Fragile X syndrome and Turner syndrome
- A low number of follicles
- Autoimmune diseases, including thyroiditis and Addison disease
- Chemotherapy or radiation therapy
- Metabolic disorders
- Toxins, such as cigarette smoke, chemicals, and pesticides.¹²

Premature menopause

Menopause which occurs prior to the age of 40 is called 'premature menopause'. Menopause which occurs between the ages of 40-45 years is called 'early menopause'. Usually premature menopause occurs due to surgery or medical treatments, however it can also occur due to POI.

As with so much of our health, genes strongly influence fertility. A woman is much more likely to experience early menopause if their mother, sister, or grandmother also experienced it early. Researchers at Stanford University have found a link between certain genetic markers and hormone levels that suggests reproductive lifespan may be very nearly fixed by genetics.¹³

Dietary interventions for low ovarian reserve

Vitamin D - Studies pretty consistently seem to show that women with low vitamin D levels tend to have lower AMH levels than women with healthy vitamin D levels.¹⁴ It seems that vitamin D plays a key role in egg survival and growth.¹⁵

Healthy weight - One study suggested that VLCDs may be beneficial for AMH levels, which is consistent with studies that suggest a healthy weight is beneficial for AMH levels.¹⁶

Coffee - A study of Japanese women found that those who went through menopause later in life were more likely to be coffee drinkers, so that gives us cause to think that maybe coffee makes a difference?¹⁷ But remember, that it's only one study, so take this research with caution.

Green and yellow vegetables – Yes, research found that women who ate more green and yellow veg were more likely to go through menopause later in life.¹⁸

Skim milk - Women who drank skim or low-fat milk more regularly have shown a delay in menopause, but not women who drank full cream milk.¹⁹

Soy foods - Soy foods are a rich source of phytoestrogens which can impact reproductive hormones, so it's not surprising that soy plays a role.²⁰

Fish - One study found that women who ate fish each day had a three-year delay in menopause compared to women who didn't eat fish.²¹

Egg freezing

Egg freezing, or oocyte cryopreservation freezes eggs to around -196°Celsius or - 320°Fahrenheit to stop all cell activity, including aging. Studies indicate that egg freezing achieves similar pregnancy rates to those of fresh oocytes.²²

A woman undertaking egg freezing will undergo Ovulation Induction, so requires nutrition to optimise egg health as discussed above.

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