Diabetes, insulin resistance, metabolic disorders, and female fertility

Why metabolism matters for fertility

Fertility is not controlled by the ovaries alone. Ovulation depends on pulsatile gonadotropin-releasing hormone from the hypothalamus, follicle-stimulating hormone and luteinizing hormone from the pituitary, ovarian estrogen and progesterone production, and the ability of the endometrium to become receptive to an embryo. Metabolic signals, including insulin, leptin, glucose availability, inflammatory cytokines, and adipokines, help the body interpret whether conditions are favorable for reproduction.

Insulin is best known for helping cells take up glucose, but it also acts as a growth and signaling hormone. When tissues become less responsive to insulin, the pancreas may compensate by producing more insulin. This state, called insulin resistance with compensatory hyperinsulinemia, is associated with prediabetes and type 2 diabetes. It can also influence ovarian steroidogenesis, hepatic sex hormone-binding globulin production, and androgen activity.

In reproductive medicine, metabolic health is therefore relevant not only for the chance of ovulation and conception, but also for early embryonic development, placental formation, miscarriage risk, gestational diabetes risk, hypertensive disorders of pregnancy, and long-term cardiometabolic health for

both parent and child.

Insulin resistance and ovulatory dysfunction

Ovulatory dysfunction is one of the clearest pathways through which insulin resistance can affect fertility. Elevated insulin levels may stimulate ovarian theca cells to produce more androgens. At the same time, insulin can reduce hepatic production of sex hormone-binding globulin, increasing free, biologically active androgens. Higher androgen exposure may interfere with normal follicle maturation, causing follicles to arrest before ovulation.

Clinically, this may appear as long menstrual cycles, unpredictable bleeding, absent periods, acne, hirsutism, or difficulty identifying a fertile window. However, metabolic ovulatory dysfunction can be subtle. Some people have occasional ovulation, some ovulate late, and others have regular bleeding that does not always confirm regular ovulation.

It is important not to self-diagnose based on cycle length alone. Irregular periods can also reflect thyroid disorders, hyperprolactinemia, hypothalamic amenorrhea, primary ovarian insufficiency, medication effects, perimenopause, or other endocrine conditions. A clinician can help determine whether insulin resistance is part of the picture.

PCOS: the common intersection of insulin resistance and fertility

Polycystic ovary syndrome is one of the most common endocrine conditions affecting people of reproductive age and is a leading cause of anovulatory infertility. PCOS is typically associated with some combination of irregular ovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology, after exclusion of related disorders. The NHS notes that PCOS can cause irregular periods and difficulty getting pregnant because ovulation may occur infrequently or not at all.

Insulin resistance is common in PCOS, including in people who are not living with obesity. Hyperinsulinemia can worsen androgen excess, and androgen excess can further disrupt follicular development, creating a reinforcing cycle. This does not mean PCOS makes pregnancy impossible. Many people with PCOS conceive spontaneously, while others benefit from structured ovulation induction,

metabolic treatment, or assisted reproductive technologies under specialist care.

PCOS is heterogeneous. Some people primarily experience irregular cycles and androgen-related skin or hair changes; others have prominent metabolic features such as prediabetes, dyslipidemia, fatty liver disease, or central adiposity. Because the pattern varies, fertility planning is most effective when reproductive goals, metabolic status, age, ovarian reserve, partner sperm parameters, and personal preferences are considered together.

Diabetes, prediabetes, and conception planning

Prediabetes and type 2 diabetes often develop in the context of insulin resistance, although genetics, age, body composition, medications, sleep, stress physiology, and other factors also contribute. Type 1 diabetes has a different autoimmune mechanism, but glucose optimization remains central to reproductive and pregnancy care.

For fertility, diabetes may matter in several ways. Chronic hyperglycemia and insulin resistance can contribute to oxidative stress, endothelial dysfunction, inflammation, and hormonal disturbance. In some individuals, these processes may affect ovulation or endometrial function. Separately, diabetes is strongly relevant to pregnancy safety: elevated glucose around conception and in early pregnancy is associated with higher risk of congenital anomalies and pregnancy complications, which is why preconception counseling is recommended for people with known diabetes.

Preconception care may include reviewing A1C targets, kidney function, blood pressure, retinal health, medications, folic acid needs, nutrition, physical activity, and timing of pregnancy attempts. Some glucose-lowering, antihypertensive, lipid-lowering, or weight-related medications may need review before conception because safety profiles differ. Medication decisions should always be individualized with a clinician rather than stopped or started independently.

Other metabolic disorders that can influence fertility

Metabolic health is broader than glucose alone. Several related conditions may

influence fertility or pregnancy risk:

Obesity and central adiposity: Adipose tissue is metabolically active. It can influence estrogen metabolism, inflammation, insulin resistance, and ovulatory function. Weight stigma is harmful and medically unhelpful; the goal is not blame, but identifying modifiable physiology and providing respectful care.
Dyslipidemia: Abnormal triglycerides, LDL cholesterol, or HDL cholesterol may cluster with insulin resistance and PCOS. While lipids are not usually the direct cause of infertility, they signal broader cardiometabolic risk that matters before pregnancy.
Metabolic dysfunction-associated steatotic liver disease: Fat accumulation in the liver is linked with insulin resistance and may coexist with PCOS. It can affect medication choices and pregnancy risk assessment.
Hypertension and vascular dysfunction: These conditions are relevant to placental health and pregnancy outcomes and should be assessed before conception when possible.
Sleep apnea: More common in insulin resistance and higher body weight, sleep apnea may worsen glucose regulation, blood pressure, and fatigue, indirectly affecting reproductive health and wellbeing.

Because these conditions often travel together, fertility care may involve collaboration among a reproductive endocrinologist, obstetrician-gynecologist, endocrinologist, primary care physician, diabetes educator, dietitian, and sometimes a cardiologist or hepatologist.

Egg quality, endometrium, implantation, and miscarriage risk

Ovulation is only one part of fertility. Metabolic dysfunction may also influence the ovarian microenvironment, oocyte competence, and endometrial receptivity. Research has explored mechanisms such as mitochondrial stress, altered follicular fluid composition, oxidative stress, advanced glycation end products, and low-grade inflammation. These mechanisms are biologically plausible, but individual fertility outcomes vary widely.

In PCOS, miscarriage risk may be influenced by multiple overlapping factors, including age, ovulation timing, obesity, insulin resistance, hyperandrogenism, and other medical conditions. In diabetes, glucose levels before and during early pregnancy are particularly important. For this reason, a person may be

advised to optimize glycemic control before conception rather than waiting until a positive pregnancy test.

Assisted reproductive technologies, including ovulation induction, intrauterine insemination, and in vitro fertilization, can be effective for many people with metabolic disorders. However, metabolic status can affect medication response, ovarian stimulation planning, anesthesia risk, pregnancy complication risk, and decisions about embryo transfer timing. A fertility specialist can integrate these variables into a safer treatment plan.

What evaluation may include

When metabolic factors are suspected in fertility difficulties, clinicians often take a broad history: menstrual pattern, ovulation signs, acne or hirsutism, weight trajectory, previous pregnancies or miscarriages, family history of diabetes, medications, sleep, exercise, eating patterns, and symptoms of thyroid or adrenal disease. Partner evaluation, especially semen analysis, is also important because fertility is shared, not solely female.

Testing may include A1C, fasting glucose, sometimes oral glucose tolerance testing, fasting lipids, liver enzymes, thyroid-stimulating hormone, prolactin, androgen testing, and assessment of ovulation. Pelvic ultrasound may be used when PCOS or structural conditions are suspected. Depending on age and history, clinicians may also assess ovarian reserve, tubal patency, uterine anatomy, and other endocrine markers.

No single insulin resistance test is perfect in routine clinical practice. Fasting insulin, HOMA-IR, glucose tolerance testing, waist measurements, triglyceride patterns, and clinical signs can each provide partial information. Interpretation depends on the person’s context, laboratory methods, and clinical goals.

Supportive approaches to discuss with your care team

Management depends on the diagnosis, age, duration of trying to conceive, cycle pattern, cardiometabolic risk, and whether pregnancy is being attempted now or planned for later. The NIDDK emphasizes that lifestyle interventions are central in insulin resistance and prediabetes, particularly nutrition quality,

physical activity, and weight-related strategies when appropriate. In fertility care, these measures are best framed as metabolic support rather than moral judgment.

Helpful topics to discuss with clinicians may include:

Nutrition pattern: A plan that supports stable glucose, adequate protein, fiber-rich carbohydrates, unsaturated fats, micronutrients, and sustainable eating habits.
Physical activity: Aerobic and resistance exercise can improve insulin sensitivity, independent of major weight change.
Sleep and circadian rhythm: Poor sleep can worsen insulin resistance, appetite regulation, and stress physiology.
Medication review: Some people with PCOS or insulin resistance may be offered insulin-sensitizing therapy or ovulation induction medication; suitability and pregnancy safety require medical supervision.
Preconception supplementation: Folic acid or prenatal vitamins may be recommended, with dosing individualized for diabetes, medications, and medical history.
Mental health support: Infertility and metabolic disorders can carry stigma and anxiety. Counseling, support groups, or fertility-informed mental health care can be valuable.

If periods are very irregular, it may be worth seeking care earlier rather than waiting a full year, especially after age 35, with known PCOS, diabetes, recurrent pregnancy loss, or other medical conditions. Timely evaluation does not mean something is wrong; it means you deserve a clear plan.