Fertility and Conception: Changes During the Past 30 Years Support the Need for Naturopathic Care

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Research on U.S. and Canadian populations indicates that all aspects of procreation, from conception through delivery, have been in a state of unfavourable decline over the last 30 years. Declining sperm counts, increasing ovulatory dysfunction, miscarriage and rising rates of caesarean section rates prevail. As naturopathic doctors, understanding the pathophysiology behind the deterioration in human reproduction will enhance our ability to counter societal, environmental and lifestyle factors that are contributing to our waning ability to reproduce.

Fertility Rates

The definition of infertility may involve some intentional form of family planning or only require unsuccessful conception after a set period of time. Typically in Canada, and for the purposes of this article, the term "infertility" refers to a lack of conception after a period of sexual intercourse without contraception (12 months for women who are under 35 years, 6 months for women over 35 years). Regardless of the definition used, the prevalence of infertility is undoubtably increasing. In fact, infertility affects approximately 16% of Canadian couples.[19,20] This is nearly double the prevalence of infertility 20 years ago (8.5% in 1992) and triple that of 30 years ago (5.4% in 1984).[20] It is estimated that infertility affects over 1.25 million couples in Canada,[21] a very unfavourable trend in both the male and female population.

Male Factor Infertility

In spite of the focus on female factor infertility, male factor infertility accounts for almost half of infertility cases.[1] During the past 50 years, sperm levels have declined from 113 million/mL in 1940 to 66 million/mL in 1990.[2] There are several theories to this multifactorial problem, most significantly the role of estrogens in the environment, the effect of oxidative stress on spermatogenesis, and the increase in sexually transmitted disease.[3]

Researchers from Washington State University have recently reported seeing effects on sperm from environmental estrogens, such as estradiol and biphenol A (BPA) exposure. Significant quantities of estradiol are found in the urine of women on oral contraceptives, which then passes through waste systems untreated and into our tap water.[5] Certain herbicides and pesticides contribute to xenoestrogen exposure. BPA has also been shown to disrupt thyroid hormones, suppress aromatase activity, and act as an androgen antagonist.[4] Men with detectable urine BPA had more than four times the risk of lower sperm count and more than twice the risk of lower sperm motility.[6] Once an egg was fertilized by the sperm in question, development to blastocyst and pregnancy rates seemed to be the same regardless of whether the sperm was from men with or without high urinary BPA.[7] This is contrary to the fact that we have seen that high urinary BPA can result in higher than average DNA fragmentation in sperm.[7] With the use of assisted reproductive techniques, including in-vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI), the effect of BPA on sperm can be overcome.[7] Of course this doesn't help those trying naturally to conceive. Phthlates are another very common chemical that people are exposed to on a daily basis which can decrease all sperm parameters.[8]

Low intake of dietary folic acid and zinc were correlated with lower motility, low vitamin E with poor morphology, and lower overall antioxidant intake was associated with poor sperm concentration and motility. Overall sperm concentration in the lower dietary antioxidant intake group was 28.6 million/mL vs 50.77 million/mL in the higher intake group, percent motility was 29.5 vs 59.4 and percent normal morphology was 38.4 vs 50.9.[10] Positive associations were also observed between dietary vitamin C intake and overall sperm count and concentration, between dietary vitamin E and motility, and between dietary beta-carotene and sperm concentration and motility.[10] There is a positive association between dietary intakes of vitamin C, lycopene, and beta-carotene on motility. Furthermore, overall semen volume increased with higher dietary intakes of vitamin C.[10,11]

The consumption of high fat foods, such as full fat dairy and meats may hurt sperm results due to the increased presence of lipophilic xenoestrogens which can concentrate in higher fat foods, whereas increasing fruits and vegetables was shown to help semen parameters. All parameters except total semen volume were better in the lower fat/higher fruit and vegetable group, most notably the percent of normal sperm morphology for the high fat group was about 3.7% compared with 22.3% in the lower fat/higher fruit and vegetable diet group.[12] Trans-fat consumption is inversely linked to overall lower semen parameters, including ejaculate volume. The lowest trans-fat consumers had on average 100 million sperm/mL whereas the highest trans-fat group had 3 million sperm/mL.[13]

Studies show that anti-oxidant supplementation can improve pregnancy rates and live birth rates in couples at fertility clinics.[14] More specifically, taking vitamin E 400 mg every day and selenium 225 mcg every day for 3 months improved sperm motility.[15] A meta-analysis of CoEnzyme Q-10 (ubiquinol) supplementation showed an overall increase in sperm seminal concentration and motility.[16] Furthermore in 2012, a study showed that using 200 mg every day of ubiquinol for 26 weeks increased sperm concentration by 81.6%, motility by 31.7% and morphology by 24%.[17] Taking 200 mcg of selenium plus 600 mg N-acetyl-cysteine every day showed a statistically significant increase in concentration, motility, and morphology of sperm.[18]

Female Factor Infertility

The female contributes significantly to the fecundity of the couple, and when comparing the prevalence of infertility in female partners over the past 3 decades, the numbers are on the rise. In 1984, a woman had about a 5% chance of experiencing infertility regardless of reproductive age; however in 2010, women aged 18 to 29 years had a 7.0-13.7% risk of infertility while women aged 40 to 44 years had a 14.3-20.7% risk.[19,20] The impact of this number grows substantially when we consider that female factors account for nearly 50% of infertility cases.[21] Female infertility can be grouped into 3 categories: ovulatory dysfunction, tubal pathology and pelvic concerns. Of these, ovulation dysfunction contributes considerably to female infertility and has been markedly affected by lifestyle changes by Canadian women.

Ovulation disorders account for 40% of female factor infertility.[22] The possible causes of dysfunctional ovulation include: aging, diminished ovarian reserve, endocrine disorders, polycystic ovary syndrome (PCOS) and lifestyle modifiers (e.g., tobacco use, alcohol intake, unhealthy weight and diet). Of these causes, there have been numerous trends over the years that are unfavourable for female fertility.

The past few decades have seen an increase in maternal age when attempting first pregnancy. Female age as a risk factor for infertility is well understood, with female fertility declining precipitously after the age of 35.[23, 24] Delayed childbearing may be due to a rise in the number of women earning higher education or joining the paid workforce; however, irrespective of cause, both males and females are waiting longer before marriage or cohabitation. The result is an increased proportion of first-born children among women aged 35 and over, from 3% in 1984 to 11% in 2011[20,21] and over 380,000 couples seeking medical assistance for conception.[20] The answer to this age problem is far from clear cut. Women should attempt conception earlier in their reproductive years; however, until financial security and career growth favour young mothers, this trend is unlikely to change in the foreseeable future without more education for women regarding factors that affect their fertility.

In addition to the impact of advanced female age, modifiable factors such as obesity have been shown to adversely affect female fertility. This is particularly relevant for Canadian women, as 45% are considered overweight, with nearly 20% of those women being obese - more than 5 times that in 1981.[24,25] Excess weight affects reproductive functioning women from the hypothalamus to the ovarian follicle. Additionally, obese women are 3 times more likely to suffer infertility than women with a normal body mass index (BMI).[26]

However, it is not all bad news for Canadian women. The percentage of women achieving moderate physical activity levels has increased over the past ten years, from 43 to 52%.[27] During this time, average daily energy intake has reduced slightly (the calories equate to that in a large banana), which should equate to a relative negative caloric balance, but this follows a decade of indulgence and women continue to eat more calories than they expend. From 1991 to 2002, daily energy intake increased 18%, with fat consumption increasing the most.[28,29] Similarly, carbohydrate intake increased 18%, primarily in the form of pasta, specialty breads and cereal-based snacks.[29] This is a concerning trend since ovulatory infertility risk is increased with elevated consumption of processed carbohydrates and there has been a direct correlation observed between ovulatory infertility and consumption of high glycemic index foods.[30] Considering these dietary trends, a moderate level of activity appears inadequate for Canadian women to maintain a healthy BMI. In fact, obesity is the most modifiable risk factor for fertility and has been found to have the greatest impact among women younger than 35 years of age.[30]

Ovulatory dysfunction is associated with other modifiable lifestyle choices, including smoking and alcohol use. The prevalence of smoking has been declining since the 1980s, from over 35 to 18% of Canadian women smoking cigarettes, with the proportion of heavy or moderate female smokers decreasing by more than 10% in the past decade alone.[20, 31] This is significant as women who smoke are 1.6 times more likely to have fertility issues than non-smokers and are less likely to have successful IVF treatments.[20] Unfortunately, over the same time period, the prevalence of heavy drinking more than doubled amongst women aged 20–34 years, from 9 to 20% [20,32]. These factors, as well as excess body weight, promote free radical production and are thought to contribute to poor oocyte quality, DNA damage and female infertility.[33]

Female factor fertility also involves the health of the fallopian tubes and other pelvic structures. Tubal factor infertility accounts for approximately 30% of female infertility cases[20] and of this, it is estimated that 64% is attributable to untreated *Chlamydia trachomatis* infections,[21] a concerning finding since the chlamydial infection rate in Canada has increased 71% for women 20–24 years of age in the past 10 years.[20] The remaining 30% of causative factors for female infertility include endometriosis, uterine complications and cervical abnormalities.[20] These factors are affected, but associated to a lesser extent, by current trends in Canadian society and infertility risk factors previously discussed.

Miscarriage Rates

While there is some disparity when assessing miscarriage statistics over the years, research suggests that rates of miscarriage are on the rise in North America, increasing by approximately 1% per year.[34] Current estimations note that 15-20% of known pregnancies result

in miscarriage,[35] and women with a history of miscarriage are at higher risk of repeat miscarriages.[36] Some researchers speculate that increased use of home pregnancy tests and artificial reproductive technologies (ART) may have artificially elevated miscarriage rates by bringing increased awareness to early pregnancies and miscarriages that would have previously gone undetected[35] yet the likely influence of other factors must not be discounted.

The most common cause of miscarriage is chromosomal abnormalities, in part correlated to advanced maternal and paternal age.[37] The risk of miscarriage begins to rise in women after age 30, with increasing risk with advancing age;[39] paternal age appears to exhibit a similar trend.[38] A trend towards women having children later in life[39] suggests that this may have a role in rising miscarriage rates.

Modifiable lifestyle factors also contribute to pregnancy maintenance. Obesity research findings parallel that of infertility, with one meta-analysis showing a 67% increased chance of miscarriage with a BMI >25,[40] whereas other research shows that being underweight also increases miscarriage risk.[41,42] Observational research also suggests an increased risk of miscarriage with caffeine intake >200mg/day (equivalent to 1-2 cups of coffee or black tea),[43] alcohol intake[42] and cigarette smoke, both in active smokers and via second hand exposure.[44,45] As described previously, there have been some significant changes in these factors that contribute to oxidative stress. Oxidant-induced endothelial damage is thought to play a role in spontaneous abortion by impairing placental vascularization and inducing phospholipid modifications.[46] These changes are linked to anti-phospholipid syndrome, a hyper-coagulability condition associated with recurrent miscarriage. Additionally, preliminary research has demonstrated an association between low vitamin B6 and early pregnancy loss.[47] Weight loss,[48] aerobic exercise[49] and fish oil[50] have been shown to decrease risk of miscarriage in those with identified thrombotic risk factors.

Stress and its effect on the immune system plays a major role in maintaining a pregnancy. Women with recurrent miscarriage appear to have higher Th1/Th2 ratios[51] and an enhanced pro-inflammatory immune system response as evidenced by increases in TNF-alpha, IL-17[52] as well as decreased immune regulation via Treg cells.[53-55] A large U.S. population-based survey tracked individual's perceived stress between 1983 and 2009, finding we are up to 30% more stressed than society was 30 years ago. Women and those under age 35 were found to be at higher risk.[56] Positive associations between high stress and miscarriage have been shown in many studies.[57] Preliminary research suggests that corticotropin releasing hormone (CRH) and other stress hormones can cause uterine mast cell activation and resultant miscarriage.[58] The role of adrenaline, noradrenaline and acetylcholine on uterine vascularization and contractility,[59] increased TNF-alpha and inflammation,[60] as well as the interplay between cortisol demands and progesterone values[61] also have been proposed. Addressing mental health in patients going through a miscarriage is prudent. A large body of evidence suggests that miscarriage is associated with increased stress, anxiety and/or depression[62,63] and that this risk may be lessened by counselling as well as exploration for cause of miscarriage.[64,65]

Environmental endocrine disruptors and toxins have become increasingly prevalent in our modernizing society and could in part explain trends towards increased miscarriage rates. BPA is a known xenoestrogen and exposure has been correlated with an increased relative risk of miscarriage.[66] Observational studies also demonstrate some evidence that exposure to pesticides,[67] anaesthetic gases,[68] radiation,[69] certain industrial solvents and electromagnetic fields may confer increased risk,[70] albeit research is preliminary in this field.

Thyroid Function: T3 and T4 have direct stimulatory effects on trophoblast function[71] and estrogen and progesterone release from placental tissue.[72] Low thyroid function has been shown to increase miscarriage rates in a number of studies,[73] even with modestly increased TSH values >1.5mIU/ml.[74]

Conventional treatments to prevent miscarriage include aspirin or heparin for proposed or diagnosed thrombophilia, human chorionic gonadotrophin (hCG), progesterone, immunotherapies including intravenous immunoglobulin and bed rest. Of these, only aspirin or heparin for diagnosed antiphospholipid syndrome[76] and progesterone for recurrent miscarriage[75] have good supported efficacy according to Cochrane reviews.

Natural Birth Rates

Despite the increased risks of maternal mortality and infant morbidity and mortality,[77] rates of caesarean delivery (CD) have steadily increased over the past 20 years and vary widely; on average anywhere from 16-60%[78] in developed nations. Such a wide variation in C-section rates would imply a lack of consensus as to which conditions warrant CD and that some of these surgical interventions may be unnecessary.

The rate of caesarean deliveries in Canada jumped from 17.5% of deliveries in 1994–1995 to 23.7% in 2002–2003[79,80] and again grew to 28% in 2010-2011.[82] The World Health Organization's recommended rate of caesarean delivery, published in 1985, is 10-15%.[83] The three primary reasons cited for CD were dystocia (abnormal or difficult labour and delivery), elective (including previous C-section) and breech presentation.[84] According to the National Consensus Conference on Aspects of Caesarean Birth, dystocia is the indication for approximately one-half of all primary caesarean sections.

Labour dystocia is an ill-defined term that is subject to interpretation. As the primary cause of caesarean section, dystocia warrants critical examination. Zhang et al. in 2010 demonstrated that labor progresses substantially slower than what was historically taught.[85] Their data indicated that labour may take over 6 hours to progress from 4 to 5 cm dilation and over 3 hours to progress from 5 to 6 cm dilation.[85] Despite this revised information, decisions about labour progression and management are still being based on Friedman's curve, a plot of cervical dilation that dates back to 1955.[86] Influences on labour progression include: unripe cervix, contracted pelvis, cervical scarring, macrosomia, fetal malposition, hypotonic or uncoordinated contractions, analgesia/anesthesia, fear and anxiety.[87]

Other contributing factors to caesarean delivery include: maternal obesity,[88] induction of labour (15% CD in induction vs 8% CD in spontaneous delivery),[94] thyroid autoimmunity (abnormal TSH/positive anti-Tg)[89] women over 45 who conceived via ART,[90] anterior placental location, advanced maternal age,[91] adenomyosis,[92] acute maternal bleeding[93] and fetal indications such as fetal weight, multiple gestation, intra-uterine growth restriction, abnormal or indeterminate fetal heart rate, oligohydramnios, placental abruption, macrosomia and post-term pregnancy.[94,95]

ADVANTAGES OF VAGINAL DELIVERY	DISADVANTAGES OF CAESAREAN SECTION
1. Quicker recovery time and no scars (2 days or less hospitalization vs 4 for c-section)	1. Greater risk of pre-term delivery and concomitant complications for the infant
2. Lower mortality risk for the mom and infant[99, 102]	2. Increased risk of complications of anesthesia, puerperal infection, and venous thromboembolism[99]
3. Lower risk of iatrogenic complications[102]	3. Higher maternal mortality (3.6 times higher after caesarean than after vaginal delivery)[99] and infant mortality (69% increase[102])
4. Birth occurs on the baby's schedule, when he or she is physically ready	4. Greater risk of post-partum depression (more than six times the risk of developing postnatal depression three months postpartum[103])
5. Vaginal birth allows the child to acquire normal flora at delivery	5. Greater likelihood of subsequent caesarean deliveries. In subsequent pregnancies, although there is a small risk of uterine rupture, blood transfusion and hysterectomy, women who attempt vaginal birth after caesarean have a much lower rate of mortality than women who have a subsequent elective caesarean.
6. Better maternal-infant bonding and lower risk of post-partum depression[100]	6. Greater incidence of allergies and asthma in children delivered by c-section[101]

Conclusion

The unfavourable trends for fertility, miscarriage and delivery witnessed over the past 30 years suggest the growing need for practitioners to prudently assess and treat hopeful parents with a slightly different emphasis than perhaps was done previously. Many of the factors negatively affecting procreation are lifestyle and environmental in nature; our modern world is affecting our waist sizes, stress levels, diet composition, toxin exposure and age of first conception, to name a few factors. Foundational naturopathic care for fertility involves appropriate investigation and intervention to address such risk factors, and highlights our integral role as health educators to maximize chances of successful reproduction.

Recommendations:

There are many specific treatments that reach beyond the scope of this article that would be indicated in treating infertility, reducing risk of miscarriage and encouraging a healthy labour. However, following are some key areas to assess for reproductive success.

NATUROPATHIC RECOMMENDATIONS TO ADDRESS CHANGING CANADIAN HEALTH TRENDS	PRECONCEPTION & FERTILITY Male	PRECONCEPTION & FERTILITY Female	PREGNANCY	LABOUR & DELIVERY
Educate patients regarding importance of family planning at a younger age	age-related infertility	age-related infertility	miscarriage risk	
Counsel patients on proper nutrition, diet and exercise to achieve healthy BMI	sperm motility & morphology	oocyte quality & quantity	miscarriage risk	maternal weight affects type of delivery
Emphasize importance of practicing safe sex as a young adult and gynecological screening exams (especially STI swabs)	lowering sperm counts	tubal factor infertility		
Reduce exposure to environmental toxins, sources of BPA and xenoestrogens	sperm concentration & motility	endocrine disruption of ovulation	miscarriage risk	
Encourage healthy lifestyle choices, notably: - avoiding exposure to cigarette smoke - reducing consumption of alcohol	oxidative damage to sperm	oxidative damage to oocytes	risk of spontaneous miscarriage	
Screen for mental health concerns, such as high stress, anxiety or depression.	age-related infertility	oocyte quality & quantity	correlated with miscarriage	
Consider naturopathic intervention (e.g. nutraceutical, herbal, acupuncture) to improve hormone balance and fecundity.	emphasis on antioxidants & specific nutrient deficiencies			
Evaluate thyroid function (TSH and anti-thyroglobulin antibodies) and treat discrepancies.		ovulatory dysfunction	TSH > 1.5-2 associated with miscarriage	Re-assess at 15-28 weeks gestation
Recommend doula care - the odds of non-indicated caesarean were 80-90% lower among doula-supported women.[105]				
Educate patients as to normal gestation period (particularly for nulliparous) and labour progression. Encourage women to labour in an upright position.[104]				reduce induction & caesarean deliveries
Recommend moxibustion at BL67 between 33-35 weeks gestation in women with breech presentation.[97,98]				

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