ANALYTIC REVIEW

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Healthy Moms, Healthy Babies: Culinary and Lifestyle Medicine for PCOS and Preconception Health

Abstract: ***Purpose of the Research:*** *Women's reproductive health issues represent a major source of burden to quality of life, productivity, and health care cost, with uneven access to care. Foundational interventions based on lifestyle and food as medicine hold promise as one equitable way to improve individual and family health. In this paper, we summarize the lifestyle and culinary medicine approaches to two of the most common reproductive health diagnoses, polycystic ovary syndrome (PCOS) and infertility.* ***Major findings:*** *For women with PCOS and/or infertility, an overall healthy eating pattern, including a whole-food plant-based or Mediterranean diet, carries clear health benefits. Exercise is of benefit in the PCOS population, and likely so for infertility patients as well. Both diagnoses are risk factors for anxiety and/or depression, and so more attention to mental health and behavioral strategies is needed. Given these findings, the notion of lifestyle interventions holds promise, but studies are overall mixed.* ***Conclusions:*** *PCOS and infertility can respond well to lifestyle and culinary interventions. These approaches, currently underutilized, can be implemented widely with minimal cost, and can also improve obstetric, neonatal, and child health outcomes via epigenetic phenomena. More research is needed to elucidate the best target populations and delivery methods for such interventions.*

Keywords: culinary medicine; lifestyle medicine; PCOS; infertility

Introduction

The economic burden of female-specific health issues, in terms of cost to the health care system and individuals, including financial expenditure, diminished quality of life and reduced productivity, is substantial. Economic analyses have estimated the annual health care expenditure of such conditions to exceed $40 billion,[1] with certain common gynecologic conditions such as polycystic ovary syndrome (PCOS), endometriosis, and fibroids estimated to affect millions of women in the U.S., with substantial cost and lost work days. The total yearly health care cost attributed to PCOS, for example, has been estimated at $15 billion with $4 billion due to PCOS-related anxiety, depression, and eating disorders.[2] Infertility is estimated to impact 10%-15% of heterosexual couples, and also negatively impacts mental health.[3] The costs of treatment for these patients, plus single and LGBT individuals seeking fertility treatment to build their families, is burdensome to most.[4] When compared to men, it is estimated that women pay on the order of $15 billion more in out-of-pocket health expenses, a burden that persists even with exclusion of pregnancy-related care.[5]

Unfortunately, despite the large burden of gynecologic pathology, there still remain systemic deficiencies in providing the best evidence-based care. Many clinicians recognize gaps in their training to provide counseling around fertility or nutrition,[6,7] and delays to diagnosis and appropriate

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care for reproductive health conditions including PCOS, endometriosis, and infertility are well-established.[8-10] In light of these holes in our health care system, increasing awareness of foundational lifestyle modifications to ameliorate or reverse symptoms or diagnoses relating to reproductive health is necessary. The six pillars of lifestyle medicine (LM)—a whole-food plant-based (WFPB) diet, sufficient sleep and physical activity, reduction of stress and toxin exposure, and social connectedness—have been demonstrated to confer positive health benefits, and yet many, if not most, women are unaware of the specific changes they could prioritize to improve their health outcomes.[11-14]

The approach of culinary medicine (CM), or utilizing food and healthy eating patterns as a tool to directly improve health, is a particularly attractive component of LM as it can simply be tailored to the unique circumstances of each patient.[15] Other components of LM may come with more caveats. Exercise, for example, while critical to health optimization, often requires more in-depth individualization to a patient's age, other health comorbidities, baseline fitness level, access to safe spaces or equipment and resources for exercise, and so forth. In the culinary approach, a WFPB diet offers uniformly positive impact on mental and physical health.[16,17] With appropriate tweaking and innovation, it can be adopted across cultural and ethnic backgrounds, with straightforward tweaks for medical comorbidities, socioeconomic status, and geography.

To provide real-world examples of how lifestyle and culinary approaches can be applied to reproductive health, this review will first delve into some foundational background around a culinary approach to women's reproductive health. In this paper, we use the terms "woman," "women," or "female" to refer to any individual with a uterus and/or ovaries, but these findings would be relevant to anyone with this biology regardless of gender identity. We will then turn our attention to focus on two of the most prevalent pathological conditions of the female reproductive system, PCOS and infertility, using a case-based approach to highlight key takeaways.

Food as Medicine

Evidence-based dietary and lifestyle interventions are widely recognized as essential strategies in medical practice for promoting women's health and preventing and managing non-communicable diseases, including obesity, diabetes, cardiovascular disease, cancer, and mental health disorders.[16-19] Food and nutrition interventions, often referred to as "food is medicine" (FIM) or "food as medicine" (FAM), represent a spectrum of services that complement federal food assistance programs like SNAP and WIC. These interventions are integrated into health care systems to enhance nutrition knowledge, improve access to healthy foods, build practical cooking skills, and address broader food environment challenges. Their overarching aim is to facilitate sustainable behavior change, address food-related social determinants of health, and improve overall health outcomes.

Food access is a fundamental determinant of health, particularly during the critical phases of preconception and pregnancy. As such, screening for food insecurity is a critical early step in developing a patient-centered FAM intervention. Nutritional patterns affect fertility, fetal development, and long-term maternal and child health outcomes. To address these needs across the lifespan, FAM interventions provide access to health-promoting foods and often medically tailored foods and meals designed to meet the specific needs of individuals managing medical conditions. Programs such as medically tailored meals, produce prescriptions, and grocery vouchers help address food insecurity while improving dietary quality, ensuring patients have access to the essential nutrients required for optimal health.[20]

In addition to food access, culinary medicine is a cornerstone of FAM as the practical application of nutrition science. CM has been previously defined as integrating culinary arts and nutrition that applies practical knowledge and skills to improve food and nutrition-related health led by a health practitioner.[15] CM goes beyond general nutrition education by emphasizing experiential learning through hands-on cooking instruction, making dietary recommendations more actionable and impactful. Examples of such recommendations are listed in Table 1. This approach has improved dietary adherence and fostered sustainable behavior change.[21]

Integrating food as medicine and culinary medicine into clinical care is already a growing practice within health care systems. For instance, the American College of Lifestyle Medicine has established a dedicated member interest group with over 1000 members focused on developing, scaling, and enhancing these programs. More specially, there are numerous examples of health systems integrating these services into clinical care. At Boston Medical Center, for example, pregnant individuals have access to an on-site food pantry, providing nutritious foods to support their health during pregnancy.[22] Additionally, culinary medicine classes are offered during pregnancy, postpartum, as well as for supporting parents in feeding their babies.

Table 1.

Examples of Culinary Medicine Recommendations for Women's Health.

Topic	Extracted Quotes Around Dietary Approaches[19]	Culinary Medicine Recommendation
Sexual health	"Apples are high in polyphenols, other antioxidants, and phytoestrogens, which together support an anti-inflammatory and anti-atherosclerogenic environment"	Add sliced apples to salads Make overnight oats with unsweetened applesauce
PCOS	"Any nutritional pattern that incorporates healthy, minimally processed, fiber-rich foods (with calorie restriction if desired for weight loss) and emphasizes adequate high-quality protein intake…."	Batch-cook grains, store in the freezer, and add to meals Add whole grains to soup for easier preparation
Gynecological conditions	"Chocolate, derived from the cacao bean, is rich in flavonoids and has been found to increase NO-mediated vasodilation, with promise for supporting sexual function" "Clinicians can recommend any nutritional pattern that incorporates healthy, minimally processed, fiber-rich foods (with calorie restriction if desired for weight)"	Prepare a chocolate mousse with raw cocoa powder and silken tofu Drain and press tofu before cooking to help it get crispy Blend silken tofu into smoothies
Endometriosis	"Omega-3 fatty acids, fruits, vegetables, and whole grains have a protective effect to reduce the risk of endometriosis and possibly contribute to regression of the disease" "A diet containing approximately 400 μg of β-cryptoxanthin per day…could be a reasonable, low-risk suggestion for patients concerned about ovarian aging"	Chop winter squash in half and roast large pieces in the oven with extra virgin olive oil. Use the cooked squash in a variety of dishes Add sliced papaya and walnuts to yogurt parfaits

Delivering Culinary Medicine. One of the biggest barriers in counseling for lifestyle modification is the method in which such counseling is delivered. It is well-known that condescending mantras such as "lose weight" or "eat better and work out more" do not deliver the desired results, and, rather, a nuanced approach must be taken to make such counseling most acceptable to patients.[23] One of the cornerstones of lifestyle medicine in general is the commitment to using motivational interviewing and shared decision-making models to engage a patient in developing a personalized plan to reach goals that they can self-identify or endorse, rather than a patronizing approach where a clinician alone decides upon a desired outcome or the means of achieving it.[24] Using the paradigm of SMART goals, which are specific, measurable, achievable, relevant, and time-bound, can assist in developing an individualized and effective plan for lifestyle improvement.[25]

When discussing food and lifestyle, some additional concepts are critical to the conversation proceeding as desired. First, maintaining a lens of cultural humility allows for grounding advice in context specific to and relevant to that patient.[26] For example, when discussing dietary patterns, using or soliciting information about the types of foods typically consumed by the patient can help make the goal more specific and relevant. While it is important to not make assumptions about what someone may eat based on presumed or reported ethnicity, demonstrating some interest and understanding of their preferred food is helpful. In many cultures, for example, rice is a staple food. Simply recommending elimination or stark reduction of rice may feel off-putting or impossible to many patients. Instead, a conversation on reducing rice consumption could touch on ideas such as limiting portion size and/or frequency of consumption, saving such occasions for family gatherings, changing ingrained behaviors such as using rice as a plate-covering "base" for one's meal, instead filling the plate with vegetables, healthy fats and proteins, and methods of preparing rice to reduce starch content, and/or substituting or mixing in whole grains. Another example would be taking the time to explain that

a "Mediterranean diet" is an eating pattern and can be applied as a construct to all cuisines, not just food from Mediterranean countries. These types of clarifications and individualization can make dietary advice much more palatable and likely to be implemented.

Second, if weight loss is part of the health goals, then it is necessary to be aware of the role of weight stigma. Many patients report delays in receiving appropriate evaluation for infertility because it is assumed that their weight is the primary issue.[27] Weight and body image are primary concerns for many women with PCOS.[28] However, rather than focusing on a specific number on the scale, or limited metrics such as body mass index (BMI), a health at every size framework can be utilized to emphasize that a healthy lifestyle has many benefits, independent of weight loss.[29,30] Even if prior attempts to lose weight have been unsuccessful, making lifestyle change is a different goal that may feel more achievable to patients and can be framed more positively.

Lifestyle and Culinary Approaches to PCOS

PCOS Pathophysiology. PCOS is a significant public health issue with systemic impact, and is one of the most common endocrine disorders of reproductive-aged women, affecting at least 5%–15%, with many remaining undiagnosed.[31] Women with PCOS can present with unique combinations of a variety of pathognomonic features (Table 2).[32] Though PCOS often presents with overweight or obese BMI, PCOS has also been independently linked to systemic inflammation.[33] As patients with PCOS can present with unique combinations of symptoms, ensuring that patients with PCOS are asked about each of these domains is critical to providing the most comprehensive clinical care. The PCOSQ is one validated tool that can measure the relative contribution of different symptoms to diminution in quality of life and reinforces the importance of holistically addressing each domain.[34]

Among women with PCOS, insulin resistance (IR) affects 75% of women with underweight or normal BMI, and 95% of those with an overweight or obese BMI.[32,35] Though current assays for IR have limited clinical relevance and there is no accepted test for IR, it nonetheless remains an important risk factor for development of prediabetes, gestational diabetes, and Type 2 diabetes mellitus, as well as weight gain. Furthermore, patients with PCOS consistently report that excess weight causes significant distress and that there is inadequate information and support around lifestyle change.[8] Health care professionals and women with PCOS alike have identified weight as a priority topic for improved clinical guidance.[32]

Despite these known associations, there is still a lack of clarity as to exactly why women with PCOS face more difficulty with weight management, and why average weight and BMI of women with PCOS have increased over time. Current theories suggest a combination of extrinsic factors, such as diet and exercise, with intrinsic ones, such as appetite dysregulation, altered metabolic rate, and variations in postprandial thermogenesis.[32] Nonetheless, in overweight or obese women with PCOS, lifestyle interventions which reduced total body weight by as little as 5% have shown metabolic, reproductive and psychological benefits.[32,36,37] Given this foundational underpinning of IR and cardiometabolic dysfunction to the PCOS phenotype, the potential for LM and CM approaches has been the source of much investigation.

Evidence for Lifestyle Interventions in PCOS. A LM approach to PCOS has been evaluated repeatedly. Fortunately, the International Evidence-based Guidelines, the result of an ongoing international multidisciplinary effort to synthesize and summarize extant data on PCOS, offer much high-level insight on the data.[32] These guidelines are a crucial

Table 2.

Common Clinical Presentations of PCOS.[32,34]

Health Domain	Possible Manifestations
Metabolic	Insulin resistance, type 2 diabetes, cardiovascular disease, metabolic syndrome
Reproductive	Abnormal uterine bleeding, endometrial pathology, infertility, obstetric complications
Dermatologic	Hirsutism, alopecia, acanthosis nigricans, acne
Mental health	Anxiety, depression, disordered eating, reduced sleep quality

Table 3.

Anthropometric Outcomes Impacted by Lifestyle Modifications in Patients With PCOS.[32]

Measure	Number of Studies	Mean Difference; [95% CI]
Waist circumference	12	−1.32 cm [−2.46, −0.18]
Waist/Hip ratio	6	−0.03; [−0.05, −0.01]
Modified Ferriman-Gallwey (mFG) score	6	−0.97; [−1.90, −0.03]
Fasting insulin	14	−1.8 pmol/L; [−3.10, −0.65]
Total cholesterol	12	−0.15 mmol/L; [−0.26, −0.03]
LDL cholesterol	12	−0.15 mmol/L; [−0.28, −0.02]

resource as they have been recently updated, represent all stakeholders in PCOS care, including patients with PCOS, and clearly grade and sort the data into relevant clinical questions.

Of note, the scientific understanding of best practices, especially around weight management, is continually evolving. As recently as the previous iteration of this guidance, published in 2018, one clinical recommendation regarding weight loss in those with PCOS and excess weight stated that an energy deficit of 30% or 500-750 kcal/day (1200-1500 kcal/day) could be prescribed, with consideration of individual energy requirements, body weight, and physical activity levels.[38] This restrictive diet, in addition to being less sustainable over the long term, does not ultimately have enough scientific evidence to recommend its widespread adoption for amelioration of PCOS symptoms or sequelae.[39] In contrast, the most recently released set of guidelines, from 2023, has revised recommendations that are much more amenable to long-term implementation and individualization for any specific patient.[32]

Much of the data looks at the cumulative impact of lifestyle interventions. In the guidelines, 18 randomized controlled trials (RCTs) were included, and these encompassed exercise and dietary interventions, as well as more minimal interventions such as a single episode of clinician counseling. Unsurprisingly, this variation contributed to heterogeneity in the findings, however lifestyle modifications overall did improve certain anthropometric outcomes (Table 3). Other measures including body weight, BMI, and additional serum cardiometabolic measures did not differ between groups.

One seminal trial that directly addresses the impact of a LM approach vs the common standard of care reported by patients can prove instructive. In a three-armed RCT, women with PCOS were randomized to a lifestyle intervention, oral contraceptive pills (OCPs) alone, or a lifestyle intervention with OCPs.[40] Both lifestyle intervention groups had statistically significantly greater weight loss and higher ovulation rates than the OCPs alone group, while the OCPs alone approach also resulted in increased odds of metabolic syndrome. This finding is important to highlight, as in clinical practice, patients diagnosed with PCOS may simply be prescribed OCPs without explanation of its role and safety profile, and without meaningful lifestyle counseling or intervention.[32]

With regards to exercise, the guidelines support the same recommendations applicable to the general population.[32] Namely, for the prevention of weight gain and maintenance of health, adults should aim for a minimum of 150-300 minutes of moderate-intensity activities or 75-150 minutes of vigorous-intensity aerobic activity per week or an equivalent combination of both spread throughout the week, plus muscle strengthening activities on two non-consecutive days per week. For greater health benefits including modest weight loss and prevention of weight regain, adults should increase to at least 250 min/week of moderate-intensity or 150 min/week of vigorous-intensity exercise. Adolescents should aim for at least 60 minutes of moderate- to vigorous-intensity physical activity daily, including muscle- and bone-strengthening activities at least three times per week.

In addition to the physical benefits, exercise and a healthy diet have also been demonstrated to confer positive mental health benefits for patients with PCOS.[41,42] Indeed, behavioral strategies can also be part of a comprehensive lifestyle

intervention. However, the consensus guidelines caution that there is no clear evidence as to how or whether to implement such approaches in addition to diet and/or exercise. In general, counseling, including cognitive-behavioral therapy (CBT) can improve the lifestyle and mental health of women with PCOS, and counseling models such as the 5A's model (assess, advise, agree, assist, and arrange) have also been shown to improve the mental health of women with PCOS.[43] Both traditional and novel approaches to mental health, including mindfulness-based stress reduction and progressive resistance training, may be of benefit in this patient population.[44] Certainly, high-quality investigation into the efficacy of behavioral interventions, and best practices for training of health care professionals in this area, would be of benefit.

In conclusion, the evidence-based recommendation is that a lifestyle intervention (exercise alone or diet combined with exercise and behavioral strategies) should be recommended for all women with PCOS to improve metabolic health. The guidelines conclude: "Healthy lifestyle behaviors encompassing healthy eating and/or physical activity should be recommended in all women with PCOS to optimize general health, quality of life, body composition and weight management (maintaining weight, preventing weight gain and/or modest weight loss)."[32] Thus, the international consensus remains that a LM approach should indeed be the bedrock of PCOS care.

Evidence for Specific Dietary Recommendations in PCOS. When specifically querying the data on diet and PCOS, many different dietary patterns have been investigated. The international guidelines included 12 RCTs with 496 participants, ranging from 4 weeks to 6 months in duration.[32] The majority of studies were in adults, and the majority of participants had an elevated BMI. Dietary interventions included the DASH (Dietary Approaches to Stop Hypertension) diet, higher protein/lower carbohydrate diets, higher fat/lower carbohydrate diets, and a pulse-based low-glycemic index diet. Macronutrient composition, when mentioned, ranged from 40%-55% carbohydrate, 15%-30% protein and 25%-40% fat, with control diets ranging from 50%-55% carbohydrate, 15%-20% protein and 25%-30% fat. Overall, the findings were of low to very low certainty but analysis showed greater improvements in BMI, waist circumference, and some indicators of IR (fasting insulin and HOMA-IR), and mixed findings for weight. No differences were seen for total testosterone and other cardiometabolic markers, including fasting glucose and lipids. There was no evidence to suggest one dietary intervention is superior to others.

Together these findings suggest that diets with a range of macronutrient compositions could be recommended for women with PCOS. General research, not necessarily specific to women with PCOS, has suggested that many different diets, including WFPB, Mediterranean, and others, appear to reduce CVD risk factors and are associated with weight loss and a lower incidence of diabetes, cardiovascular disease and cardiovascular mortality.[17,18] As such, rather than a blanket restriction on carbohydrates, selecting carbohydrates characterized as high-fiber, lower glycemic index, and including whole grains, pulses/legumes, and fruit appears prudent.

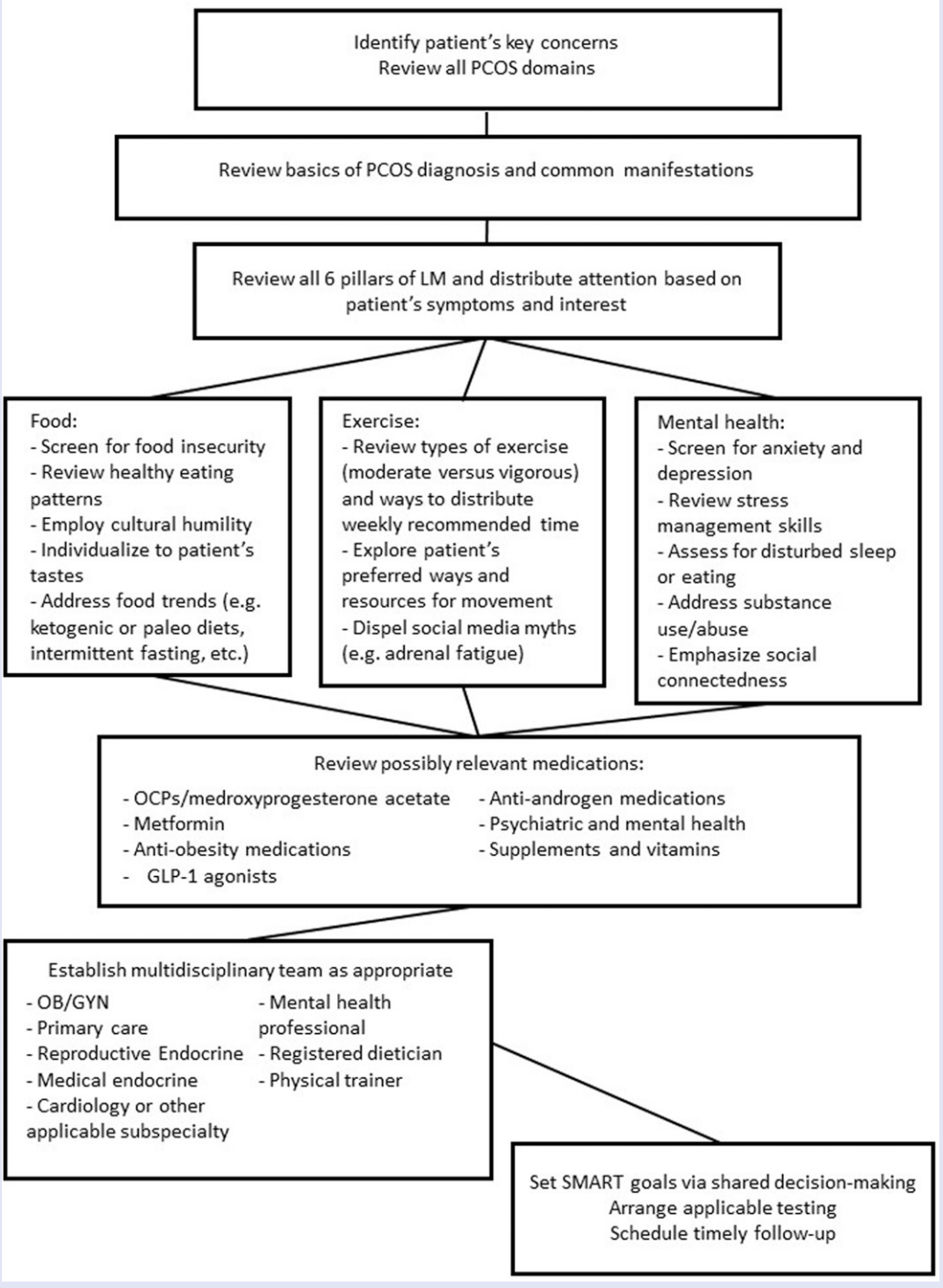
In summary, a range of healthy eating patterns can be effective and there is much room for individualization. The international guidelines make a few key statements physicians and other clinical providers should internalize: (1) "health care professionals and women should consider that there is no evidence to support any one type of diet composition over another for anthropometric, metabolic, hormonal, reproductive or psychological outcomes," (2) "any diet composition consistent with population guidelines for healthy eating will have health benefits, and within this, health care professionals should advise sustainable healthy eating tailored to individual preferences and goals," and (3) "tailoring of dietary changes to food preferences, allowing for a flexible, individual and co-developed approach to achieving nutritional goals and avoiding unduly restrictive and nutritionally unbalanced diets, are important, as per general population guidelines."[32] In other words, an individualized diet and exercise approach developed in a shared manner between clinician and patient with clearly identifiable goals along the way is the gold standard of management. To make these generalizations more concrete, let us consider a typical case:

Case Study #1. Patient R.L. is a 23yo G0 female presenting for evaluation of irregular cycles. She underwent menarche at age 15, but cycles remained sporadic thereafter, often skipping a month or two. At age 18yo, her mother took her in for evaluation and she was put on OCPs. Over the past year, she has seen a number of videos on social media ascribing negative health outcomes to OCPs and so she self-discontinued the pills 8 months ago. She had one withdrawal bleed at that time, but no subsequent bleeding. Further, in this interval, she has gained 20 lbs., and feels her skin and mood are worse.

In helping this patient, and others like her, there is a standard algorithm that can help guide the conversation (Figure 1). Starting with a thorough history, eliciting patient symptoms across all PCOS domains, and then educating the patient on the fundamental knowledge every

Figure 1.

A template to guide comprehensive LM/CM conversations in the clinical care of patients with PCOS.



patient with PCOS should have regarding the diagnosis and its common manifestations begin the conversation. Then, we review all 6 pillars of LM and figure out where attention is best placed for that specific patient. This section of the conversation is ideal for discussing food trends, which may help some individuals but still need more research, such as intermittent fasting[45] or ketogenic diets.[46] Myths

can also be dispelled, such as the persistent misconception that due to so-called adrenal fatigue, women with PCOS should avoid exercise.[47] Pharmaceutical treatment and a multidisciplinary care team can be introduced, and then an initial treatment plan, including goals for lifestyle modification and established follow-up can be set.

In following this clinical algorithm, we can ensure our patient R.L. understands her diagnosis, how it relates to her ongoing complaints, and how she can best safeguard and improve her health moving forward. With a shared decision-making approach, we identify key SMART lifestyle goals and establish regular follow-up, make decisions regarding contraception and indications for resuming OCPs or utilizing medroxyprogesterone acetate for endometrial protection, and pursue medical workup as appropriate, ensuring no other comorbidities and referring for therapy or dermatologic assistance. We can also gently help patients realize the dangers of obtaining medical guidance via social media; posts on PCOS are laden with conflicts of interest and incorrect information.[48]

Lifestyle and Culinary Approaches to Infertility

Pathophysiology of Infertility. Similar to PCOS, infertility is a common condition primarily ascribed to the reproductive system, but with potential systemic implications that seem potentially sensitive to a LM approach. When assessing heterosexual couples, at least a third may be primarily attributed to a male partner, whilst in considering female factors, diminished ovarian reserve, ovulatory dysfunction, and tubal or uterine pathology comprise the bulk of diagnoses.[49] Importantly, up to 15%-20% of cases of infertility fall under the category of unexplained infertility, which has been hypothesized to be in some cases due to systemic issues such as lifestyle, environmental, or other factors.[50] There are many situations in which potential inflammatory conditions (endometriosis, PCOS) may be involved, or diagnoses known to be sensitive to a LM/CM approach (fibroids, endometriosis, PCOS) may be at play.[19] Inflammation has also been theorized to contribute to irregular menstrual cyclicity, implantation failure, and other poor outcomes.[51] Stress can also negatively impact ovarian reserve and may contribute to infertility.[52,53] Regardless of the exact etiology, infertility is a source of substantial grief and quality of life impairment, and, as such, similarly to PCOS, there is much interest in how lifestyle can impact both natural fertility and infertility treatment outcomes via gains in physical and mental health.

Anovulation or oligo-ovulation, accounting for approximately 25% of cases of infertility, often result from underweight, overweight, or obese BMI.[49] Eating disorders, most frequently anorexia nervosa, are the most common cause of infertility among underweight women, along with the relative energy deficiency in sports (RED-S) syndrome and other chronic conditions, and can cause ovulatory dysfunction via hypothalamic suppression, loss of adipose tissue and resultant hormonal imbalance.[54] On the other end of the BMI spectrum, obese women have been demonstrated to have higher rates of anovulation, as well as subtler forms of menstrual dysfunction, worse outcomes in infertility treatment possibly mediated through altered folliculogenesis and diminished oocyte quality, altered endometrial environment, and a higher rate of miscarriage and other obstetric and neonatal complications.[55] However, it is important to note that the ovulatory dysfunction in obese women is likely often due to a PCOS diagnosis, and the true rate of ovulation and fertility difficulty in ovulatory obese women is not clearly delineated.

Evidence for Lifestyle Interventions in Infertility. With regards to the nexus of infertility and lifestyle, the data most clearly address two specific populations, which often overlap: those with anovulatory infertility, and those with overweight or obese BMI. With regards to anovulatory infertility, the data is relatively supportive that even modest efforts at normalizing weight can have a positive impact. Underweight women able to correct energy imbalance, often requiring intensive multidisciplinary management, can often regain regular ovulatory status. Though delineating exactly how many anovulatory overweight or obese women meet PCOS diagnostic criteria remains an unanswered question in the literature, the presumption remains that it is the majority, and as has already been discussed, even a 5% weight loss can result in recovery of ovulation status in those women.[56]

When looking at those who are overweight or obese, various systematic reviews and meta-analyses have demonstrated a possible positive impact of lifestyle modification on pregnancy rate. A 2017 meta-analysis including 8 studies, primarily targeting overweight or obese subfertile women, found that in addition to a greater reduction in weight and BMI with intervention, the only significant fertility outcome was an increased natural pregnancy rate (odds ratio [OR]: 1.87, [95% CI: 1.24, 2.81]).[57] It is worth noting that the weight-related changes were very modest: mean differences were −3.48 kg [95% CI: −4.29, −2.67] for weight and −1.40 kg/m2 [95% CI: −1.95, −0.84] for BMI. In 2021, a Cochrane review on preconception lifestyle advice for patients with infertility updated an initial iteration from 2010,[58] which had identified no RCTs for inclusion. In the updated

review, 7 RCTs were included but the quality of the data was rated low to very low with equivocal findings concluding that preconception lifestyle advice may result in little to no difference in the number of live births.[59] The review also demonstrated low confidence in whether lifestyle behaviors are actually modified with such preconception interventions.

Perhaps the most recent thorough analysis on the topic came to similar conclusions. A 2024 meta-analysis identified 16 eligible RCTs for preconception weight reduction in women with overweight or obesity planning pregnancy, and found that women randomized and exposed to a weight loss intervention were more likely to become pregnant (relative risk [RR] 1.24 [95% CI 1.07, 1.44]), but not to have live birth (RR 1.19 [95% CI 0.97, 1.45]) or miscarriage (RR 1.17, [95% CI 0.79, 1.74]) compared with women in control groups.[60] Further, subgroup analyses revealed that women randomized to weight loss interventions lasting 12 weeks or fewer were more likely to get pregnant, and the relative risk of miscarriage was 45% higher (RR 1.45, 95% CI [1.07-1.96]) in intervention groups who underwent fertility treatment. So, an approach requiring weight loss interventions before attempting natural conception or assisted reproductive technologies (ARTs) is not necessarily an evidence-based approach to increase the live birth rate.[44,60,61]

Certainly, there may be subgroups for whom this conclusion is incorrect. For example, one interesting finding of the 2024 meta-analysis was that the BMI ≥35 kg/m^2 group may be at most benefit (RR 1.54; 95% CI, 1.18-2.02 compared to control women), and this will be interesting to further evaluate in forthcoming literature surrounding the impact of GLP-1 agonists, which can induce a much greater degree of weight loss than prior interventions, lifestyle or pharmacologic.[62] Such data could help elucidate the impact of more substantial weight loss, or among groups with higher starting BMI, on infertility.

However, from what is currently known, the American College of Lifestyle Medicine guidelines for preconception health include a normal BMI, achieved and/or maintained at least in part through a WFPB approach. Specific micronutrients are called out in these guidelines (fiber, folate, and vitamin D), and the elimination of high risk food (processed meats and high-mercury fish) recommended. The American Society for Reproductive Medicine (ASRM) has two documents that draw relevant clinical conclusions. The ASRM Committee Opinion on "Obesity and Reproduction" concludes that among "overweight and obese women, the data suggest that lifestyle interventions, weight loss medications, and bariatric surgery lead to significant weight loss and may improve chances of unassisted conception; however, their effects on birth outcomes are still unclear."[55] The ASRM Committee Opinion on "Optimizing Natural Fertility" states that "although a healthy lifestyle may help to improve fertility in women with ovulatory dysfunction, there is little evidence that dietary variations, such as vegetarian diets, low-fat diets, vitamin-enriched diets, antioxidants, or herbal remedies, improve fertility in women without ovulatory dysfunction or affect the sex of the infant. In general, robust evidence is lacking that dietary and lifestyle interventions improve natural fertility, although dietary and lifestyle modifications may be recommended to improve overall health."[63]

And so, while there remains some lack of clarity on the best situations to utilize preconception weight loss or lifestyle interventions, there does remain great interest in trying to identify which exact interventions, if any, may help. Approaches relying on improved technological approaches may be one avenue for improved outcomes; indeed, a Dutch study of mobile coaching program for subfertile couples undergoing IVF showed that nutrition could be improved over the 24-week intervention.[64] Multiple trials from around the world have been announced to investigate more thoroughly the possible impact of lifestyle interventions in the preconception phase.[65-69] As such, perhaps better data are on the horizon. In the interim, there are other compelling reasons to pursue preconception lifestyle optimization.

Aside from possibly impacting actual treatment outcomes, preconception LM interventions may offer additional potential benefits. First, these approaches may help infertility patients feel a sense of autonomy and support through the treatment journey,[70,71] ultimately assisting them to stay in treatment, one of the greatest predictors of success. Weight loss for obese patients prior to ART procedures, such as egg retrieval, can reduce procedural and anesthetic risk.[55] Importantly, healthier lifestyle and/or BMI can also improve obstetric and neonatal outcomes. For example, in one study, the combination of six factors (BMI 18.5-24.9, nonsmoking, moderate-to-vigorous physical activity of 150 min/week or more, healthy eating [top 40% DASH score], no or low-to-moderate alcohol intake [less than 15 g/d], and use of multivitamins) was inversely associated with risk of adverse pregnancy outcomes in a dose-dependent manner. Compared with women with 0-1 healthy lifestyle factor, those with all 6 had a 37% lower risk of adverse pregnancy outcomes (RR 0.63, 95% CI 0.55-0.72), driven primarily by lower risks of gestational diabetes, gestational hypertension, and low birth weight. This study concluded that if the observed relationships were causal, 19% of adverse pregnancy outcomes could have been prevented by the adoption of all six healthy lifestyle factors (population attributable risk 19%, 95% CI 13%-26%).[72] In other words, helping patients improve lifestyle in the preconception phase can

Table 4.

Micronutrients and Macronutrients Implicated in Fertility Outcomes.[19,63,74,78]

Possibly or Likely Beneficial	Possibly or Likely Harmful
Multivitamins, folic acid	Trans fatty acids
Long-chain omega-3 fatty acids	Red and processed meats
Full fat dairy	Refined carbohydrates
Whole grains	Glycemic load/added sugars
Vegetables	
Fish	
Soy isoflavones	

have many benefits in addition to possibly improving fertility outcomes.

As such, the potential of preconception lifestyle improvement as a public health measure is large. Data throughout the developed world demonstrate high rates of poor preconception lifestyle in the forms of suboptimal nutrition, obesity, uncontrolled medical conditions, non-replete folate status, toxin use and abuse, and so on.[19] In thinking more broadly about how to improve pregnancy outcomes, we must start with preconception health, when lifestyle choices can initiate fetal programming that will ultimately influence fertility, obstetric, neonatal, and child health outcomes.[73]

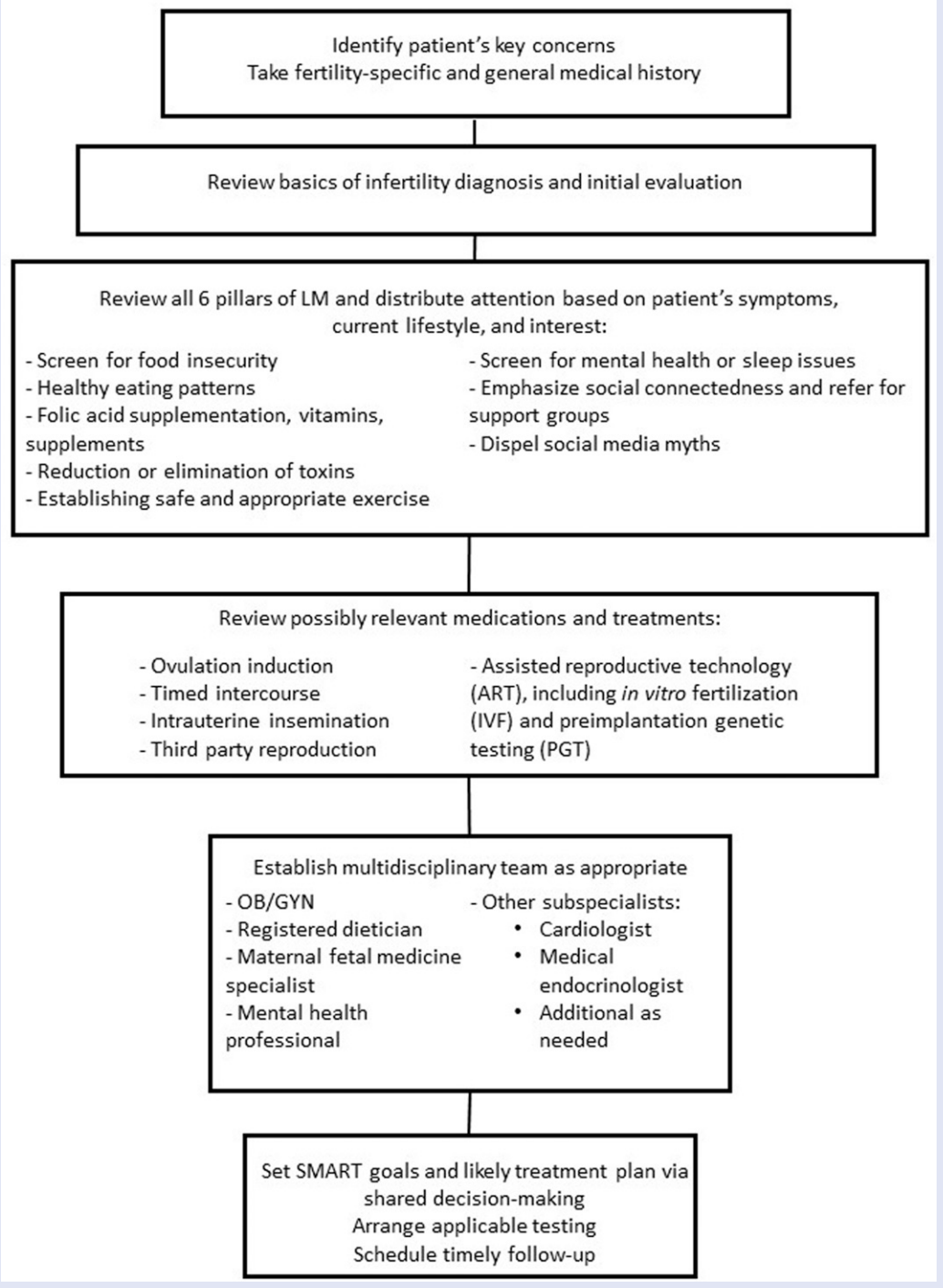
Evidence for Specific Dietary Recommendations in Infertility. There is abundant research specifically on food and fertility. Though every published study does not perfectly align in findings, there is enough consensus to drive some advice around specific micronutrients, dietary patterns, and general health in the preconception timeframe. Certain papers and society opinions are instructive in parsing the data in more detail.[19,63,74]

In brief summary, there is a body of literature studying dietary patterns and natural conception. A healthy preconception diet is generally thought to decrease the length of time to pregnancy.[74,75] Multiple cohort studies assessing the association between dietary patterns and fertility show that "healthy" eating patterns have a generally positive effect, in line with the US Dietary Guidelines, which recommends high consumption of whole grains, monounsaturated or polyunsaturated oils, vegetables, fruits, and fish.[74] The Nurses' Health Study II assessed an investigator-defined "fertility diet," which encouraged higher consumption of monounsaturated rather than trans fats, vegetable rather than animal protein sources, low-glycemic carbohydrates, high-fat dairy, multivitamins, and iron from plants and supplements.[19,76] The study demonstrated that increasing adherence to this diet was associated with a lower risk of infertility related to ovulatory dysfunction (RR 0.34 [95% CI: 0.23, 0.48]) and a lower risk of infertility (risk reduction 27% [95% CI: 5%, 43%]) from other causes, when compared with women with the lowest intake of this diet pattern. In another study, those in the highest quartile of adherence to the Mediterranean diet, which similarly includes high intake of vegetables, fish, and polyunsaturated oils, had 44% (95% CI: 35%, 95%) lower odds of seeking medical help for difficulty getting pregnant compared with women in the lowest quartile.[77]

In contrast, unhealthy dietary patterns and foods consistently show a negative impact on fertility. In a large study of women with low-risk singleton pregnancies, a statistically significant trend was seen in the median time to pregnancy when comparing those who consumed fast food ≥4 times/week with those in lower consumption categories.[75] The typical Western diet is often characterized by micronutrient deficiencies, inflammation, and higher intake of trans fats and red meat, all of which have been implicated as having potential adverse effects on fertility.[19,63,74] Of note, other foods sometimes interrogated as possibly harmful, such as dairy and soy, have not generally been found to exert negative effects.[74] In summary, the following micro and macronutrients have been implicated as likely beneficial or harmful (Table 4).[63,78]

Figure 2.

A template to guide comprehensive LM/CM conversations in the clinical care of patients with infertility.



As we have previously concluded, the data are heterogeneous, but most strongly support a healthy diet with the goal of avoiding gross micronutrient deficiencies.[19] Selecting a healthy dietary model that is plant forward and diverse, with supplementation via a prenatal multivitamin, appears a reasonable evidence-based approach given the extant literature.

There are other studies that have evaluated diet in relation to outcomes in women utilizing ART. In a cohort study of women utilizing ART, assessing a "pro-fertility diet" (higher intakes of supplemental folic acid, vitamin B12, vitamin D, low-pesticide produces, whole grains, dairy, soy foods, and seafood rather than meats), demonstrated an increased probability of live birth among those with higher pretreatment adherence to the pro-fertility diet.[79] Similarly, studies among patients using ARTs have found that greater adherence to the Mediterranean or the Dutch (high intakes of whole grains, monounsaturated or polyunsaturated oils, vegetables, fruits, meat or meat replacements, and fish) diet[80] have variably been associated with some positive outcomes, including yield of fertilized eggs and embryos, and higher rates of positive pregnancy tests, ongoing clinical pregnancy, and live birth.[63] In a Greek study, compared with women in the highest tertile of Mediterranean diet adherence, women in the lowest tertile had significantly lower rates of clinical pregnancy (29.1% vs 50.0%; $P = .01$) and live birth (26.6% vs 48.8%; $P = .01$). Among women <35 years old, increased diet score was associated with an ~2.7 times higher likelihood of achieving clinical pregnancy and live birth.[81] Alternatively, other cohort studies in ART patients found no associations between diet and treatment outcomes.[63,82]

Some discrepancies in the global data may be due to baseline demographics, including rates of overweight and obesity, and the food quality and eating patterns in a given country or patient population. As with the PCOS case, higher weight classes may have the most to gain from intervention. When weight or BMI have been studied in the IVF context, they can play a substantial role. In a large retrospective cohort of 51,198 women undergoing their first IVF cycle, those with overweight or obese BMI experienced greater odds of cycle cancellation, fewer oocytes retrieved, fewer usable embryos, and lower rates of clinical pregnancy.[83]

As previously discussed, diet also influences mental health, and healthy eating patterns could positively impact resilience through the infertility journey. Though the extant literature has not established any relationship between dietary patterns and pregnancy loss,[63] maternal mental health can also have positive epigenetic impact.[84] Thus, we can draw the conclusion that overall the data supports multiple reasons to promote healthy dietary models and lifestyle in achieving pregnancy and maintaining optimal physical and mental health from preconception through pregnancy. To further delve into the application of these findings into clinical practice, let us consider another case study.

Case Study #2. Patient A.C. is a 38-year-old G1P0010 with a prior spontaneous abortion at 7 weeks that occurred nearly a year ago. She has been trying to conceive for 16 months.

As with our first case, we can follow a general clinical counseling algorithm to help us best assist this patient (Figure 2). We start as always with a detailed history, review basics of the infertility diagnosis and initial evaluation,[85] and then move on to review the data surrounding LM approaches. Whereas in the PCOS case, where symptoms may entirely resolve with lifestyle modifications, additional treatment is more likely necessary in the infertility context. As such, the conversation can treat LM as a foundational branch of treatment to be used in conjunction with any chosen management plan, and can emphasize its role in possibly improving time to the desired outcome of viable pregnancy and likely optimizing outcomes during pregnancy and beyond.

Infertility patients are often highly motivated to consider lifestyle change, but barriers are also there.[86] Balancing treatment initiation with lifestyle modification and optimization can result in many different potential journeys. A patient may choose a gradual approach to treatment, or particularly in the context of advanced reproductive age or a strong desire for multiple more pregnancies, may proceed straight to ARTs to most efficiently achieve both pregnancy and fertility preservation. Indeed, a patient like A.C. may ultimately make intentional lifestyle modifications while planning an IVF cycle with preimplantation genetic testing for aneuploidy. When sufficient euploid embryos are achieved, she can initiate embryo transfer with the goal of maintaining some embryos in cryopreservation for a future sibling.

Conclusion

In summary, lifestyle and culinary medicine approaches can inform ideal management strategies for PCOS and preconception health. In addition to general health improvement, other benefits also accrue: gains in mental health, fertility, and obstetric, neonatal, and child health through the synergistic impact of a healthier intrauterine environment and epigenetics. Achieving healthier pregnancies on a societal level holds promise in possibly reversing troublesome national trends in pediatric obesity and health. As such, improving and increasing awareness around lifestyle optimization for reproductive-aged women represents one underutilized approach to elevating our public health as a nation.[87]

To achieve this goal, a multipronged approach is needed. Training physicians better in nutrition and lifestyle medicine,[88] reforming our health care system to allow time and resources for well care rather than sick care,[89] utilizing non-physician providers and enhancing access to registered dieticians,[90] and continued growth of multidisciplinary specialties like LM, CM, obesity medicine, and others, can all help.

Social media is another tool, albeit frustrating at times, which can and likely should be utilized. Despite an evidence-based foundation for the field of LM, there is still drastic underutilization of these techniques and knowledge within the realm of conventional Western medicine. At the same time, social media influencers often emphasize the notion that conventional medical approaches are insufficient, misguided, or overly reliant on pharmaceutical interventions, often propping up programs or supplements sold at a profit. Online resources for reproductive health care advice may often be inaccurate.[91] In many cases, this causes patients to choose between traditional medical care and unproven alternative approaches.[92] For example, consider the online backlash against oral contraceptive pills (OCPs), which can be a reliable contraceptive in addition to treatment for abnormal uterine bleeding, hormonal aberrations including in the context of diagnoses such as PCOS, or dysmenorrhea. Situating evidence-based medical reproductive health interventions in the context of a comprehensive LM health plan, as in the first case study here, can neuter many of the claims of physicians as mere pill-pushers.

In conclusion, women's reproductive health care represents a large source of health care expenditure, and is a market poised for continued growth.[93] The continued advent and awareness of LM and CM approaches can help reduce the burden of disease and with further research identifying the best interventions, personalizing them, and optimizing delivery, has promise to also restore faith and confidence in the patient–physician relationship.

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