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Complex Relationships Between Food, Diet and the Microbiome

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Abstract

Diet is a risk factor in a number of medically important disease states including obesity, celiac disease and functional gastrointestinal disorders. Modification of diet can prevent, treat or alleviate some of the symptoms associated with these diseases and improve general health. It is important to provide patients with simple dietary recommendations in order to increase the probability of successful implementation. These include increasing vegetable, fruit and fiber intake, consuming lean protein sources to enhance satiety, avoiding or severely limiting highly processed foods, and reducing portion sizes for overweight and obese patients. Women can play an important role in maintaining family health by making more informed dietary decisions. The gut microbiome may play a role in some gastrointestinal disorders. However better designed studies are required to differentiate correlation from causation in this emerging area.

Keywords

Celiac disease; Diet; Food; Functional GI disorders; Microbiome; Nutrition; Obesity; Women's health

Introduction

For the vast majority of human evolution our ancestors had been hunter-gatherers, migrating to take advantage of seasonal food availability from wild plants and animals. With the advent of agriculture approximately 10,000 – 12,000 years ago humans began to take active roles in food production, which paved the way for major societal changes, such as the establishment of complex social organizations and the development of science, technology, and medicine. Since the dawn of agriculture humans have been breeding plants and animals, actively selecting for particular, desirable traits of their food. However, recent major technological advances in food production -- from agricultural practices, food harvesting,

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processing, preservation, and distribution -- have inadvertently led to the modern world's greatest threat to human health; obesity.

In the United States greater than two-thirds of adults are classified as overweight (BMI of 25.0-29.9 kg/m²), and more than one-third are classified as obese (BMI of 30 kg/m² and above)¹. In 2010 the annual medical costs associated with obesity in the United States were estimated at 160 billion dollars, with indirect costs associated with obesity estimated at another 450 billion dollars. The obesity epidemic correlates closely with major changes in food production practices and consumption patterns. Currently less than 20% of Americans consume what would be considered a healthful diet; which should include multiple daily servings of vegetables and fruits along with lean protein sources. Most Americans now consume the majority of their daily calories from processed foods, which includes the preponderance of prepared foods purchased from restaurants or grocery stores².

As physicians we are witnessing a significant change in another chronic disease that may also be related to alterations in dietary habits. Celiac disease is an immune mediated enteropathy that manifests in some genetically susceptible individuals (HLA-DQ2 and/or HLA-DQ8) upon exposure to dietary gluten; protein complexes found in wheat, rye, and barley. The prevalence rate of celiac disease in the 1950's was approximately 0.02% and today is closer to 1%³. Historically celiac disease was diagnosed in childhood, however now diagnosis is becoming more common at nearly any age. The explanation for this dramatic increase in prevalence remains unclear. There does not appear to have been an increase in overall wheat consumption during this period of time, however major changes to the way in which cereal grains are processed for modern foods have led some to speculate that modifications associated with processing may be responsible for the increased prevalence of celiac disease. It is certain that changes in human population genetics cannot account for the increased prevalence, since celiac disease susceptibility genes remain at stable frequencies (~30%) within the United States population.

Functional gastrointestinal disorders (FGIDs) which are defined as symptoms arising from the gastrointestinal tract without an identifiable structural or biochemical etiology⁴ represent other processes that may also be related to diet. Irritable bowel syndrome (IBS) is the most common FGID, affecting an estimated 15% of the general population in Western countries and 11% worldwide⁵. The vast majority of afflicted individuals report at least one food trigger^{6,7}. Women with IBS report more food items as potential triggers for their symptoms than men. Furthermore, individuals that report more food triggers have lower quality of life scores and more severe IBS symptoms⁶. An intriguing recent study by Fritscher-Ravens et al., demonstrated real-time mucosal changes after exposure to certain food antigens using confocal laser endomicroscopy (CLE) in IBS patients⁸. In the group of individuals that experienced mucosal changes with food antigen application, dietary elimination of this specific food antigen lead to dramatic improvement or complete resolution of their IBS symptoms that was durable at one year of follow-up. This work strongly suggests that food is playing a major role in the etiology of IBS symptoms and provides a potential method to identify specific food triggers that could allow physicians to make better dietary recommendations for their patients.

Many patients seek guidance for dietary changes they can implement in an effort to alleviate their symptoms, but often lack the knowledge or motivation to implement these recommendations. Furthermore, because of the complexity of diet and food choices, getting people to embrace and adhere to major dietary changes is difficult. As a society we seem to have lost sight of the fact that our diet is a major determinant of our health, health expectancy, life expectancy, and overall quality of life and can be a powerful tool in preventing disease and ameliorating symptoms of disease.

A review of the literature did not produce a consensus regarding the effects of gender on the response to specific dietary interventions or dietary adherence. However, for the majority of households within the United States, food choices are primarily dictated by women and women with greater food knowledge are better able to appropriately implement healthful dietary interventions⁹. Therefore targeting women with dietary advice and nutrition-focused education has the potential to have far greater effects that could benefit the entire household.

In this article we will discuss the complex relationship of food and diet in the context of women's health. We will encourage you to simplify the dietary recommendations you suggest to your patients in an effort to develop consistent messages about food and diet choices and increase compliance.

Food Consumption Patterns

Food consumption patterns in the United States have changed dramatically over the past few decades for multiple reasons. During this time period there have been major advancements in food processing and preservation technologies that have allowed for longer-term storage of prepared processed foods. This combined with more women entering the out of home workforce has created an environment in which food preparation within the home has significantly declined. Within the majority of households, women traditionally have been responsible for food procurement and preparation, a pattern that has not changed significantly despite more women entering the out of home workforce². This has lead to a decrease in time allotted for food preparation related activities and therefore to greater demands for prepared or partially prepared processed foods that require less preparation time². With these changes, there has also been a concomitant increase in consumption of higher calorie, lower nutrient dense foods to the detriment of the consumption of fresh vegetables and fruits.

For many people there is a lack of understanding of the important contribution food makes to overall health. Individuals no longer view food consumption as a necessary part of a healthy lifestyle and therefore are failing to see the direct consequences of poor food choices on their health and the development of disease.

Current Diet Trends

The clinical definition of diet is simply the total food intake by an individual over a given time period. However for many people diet is defined as a short-term intervention to accomplish an objective such as weight loss. These types of diets are often associated with unsustainable or unhealthy food restrictions, which can reduce the long-term effectiveness of

these interventions. For others, diet is a necessary medical therapy, such as those with celiac disease, who must commit to life-long avoidance of foods containing gluten in order to maintain health and minimize adverse outcomes from untreated disease. Some individuals consume certain diets because of a belief they represent a “healthier” way of eating, while other individuals avoid certain foods such as meat, dairy, or eggs due to religious restrictions or concerns for animal welfare and the environment.

As physicians we encounter individuals that are interested in treating their ailments or preventing the development of disease with diet modification, yet most people in the United States do not consume a healthy diet. The reason for this contradiction is complicated. As physicians we often fail to provide consistent messages about what constitutes a healthful diet, especially given the seemingly contradictory recommendations for patients with certain medical conditions. This problem is also confounded by the fact that an individuals' motivation, level of knowledge, time, and finances all vary, as do their baseline nutritional state and medical comorbidities. Here we review some of the more common dietary trends and argue that for most people simplified dietary recommendations can be made to achieve both overall better health and to treat a wide range of underlying medical conditions (Table).

Over the past few years physicians have been recommending diets for a number of different conditions such as weight loss, diabetes, cardiovascular disease, hypertension, or symptoms related to IBS. Examples include the low-carbohydrate diet for management of weight loss or diabetes, the low-fat diet for management of cardiovascular disease, the low-salt diet for management of hypertension, and the low-Fermentable Oligo-, Di-, Mono-Saccharides and Polyols (FODMAP) diet or the Mediterranean diet for management of IBS. Many physicians recommend these dietary interventions with little knowledge of what these diets entail or what burden this type of diet may place on their patients. Furthermore, when individuals are left to decipher the nuances of these particular diets themselves, they often become confused and frustrated with the conflicting information available to them.

For many physicians time is also a factor in counseling our patients regarding healthful food choices. We often refer our patients to nutritionists or dieticians and have little knowledge of the quality or validity of their recommendations or follow-up care. In this article, we argue that simplification of nutritional recommendations will make physician counseling easier, less time consuming, and less cumbersome for patients to implement.

In the following paragraphs, we will review some of the more common diets that are encountered in clinical practice. We will discuss the basic nutritional principles that form the foundation of these diets and describe some common pitfalls associated with them. This will provide you with the information required to educate your patients, empowering them to make healthful food choices.

Low-Carbohydrate Diet

The basic principle of the low-carbohydrate diet is to restrict the total daily calories from carbohydrate intake. The Institute of Medicine, Dietary Reference Index defines that the consumption of between 45-65% of total daily calories from carbohydrates as normal¹⁰.

Therefore less than 45% of daily calories from carbohydrates can be considered a low-carbohydrate diet. When coupled with overall calorie restriction, these diets typically result in weight loss and beneficial metabolic changes¹¹. However, some often interpret the focus of this diet solely on the carbohydrate restriction, without calorie restriction and end up replacing the calorie reduction achieved from carbohydrate restriction with those from fat or protein consumption, which in turn can reduce or negate the positive health effects of this dietary intervention. The major pitfall of this diet is that without concomitant calorie restriction the health benefits of carbohydrate restriction are lost. Another pitfall of this diet is that it does not differentiate between carbohydrates from vegetables, fruits, and whole grains with those from processed foods, which have been shown to have differing effects on cardiometabolic parameters¹².

Low-Fat Diet

The basic principle of the low-fat diet is the restriction of total daily calories from fat intake. The Daily Reference Intakes from the Institutes of Medicine recommends that 20-35% of total daily calories should be from fat¹⁰. Therefore a low fat diet would constitute a diet of less than 20% of total calories. Fats from the diet are a necessary energy source and aid in the absorption of fat soluble food components such as the vitamins, A, D, E, and K. A diet too low in fat can lead to fat soluble vitamin and other micronutrient deficiencies. The intention of this diet is to reduce total daily calorie consumption from fat and replace those calories with the consumption of vegetables, fruits and lean protein sources, while also implementing overall daily calorie restriction. However, the major pitfall of this diet is that the calories avoided by fat consumption are often replaced by consumption of refined sugars and processed foods¹³.

Low-FODMAP Diet

The low-FODMAP diet aims to limit foods containing fermentable oligo-, di-, and mono-saccharides and polyols in an effort to treat IBS. Saccharides are simply sugars and can be either naturally occurring in food (intrinsic) or added during food processing or preparation (extrinsic). Glucose and fructose are examples of mono-saccharides. Sucrose and lactose are examples of di-saccharides. Sucrose is comprised of the mono-saccharides glucose and fructose and when extracted and refined from cane, becomes common table sugar. Lactose is comprised of the mono-saccharides, galactose and glucose and found primarily in mammalian milk sources. Lactose is broken down to its constituent mono-saccharides by intestinal lactase. The persistence of intestinal lactase production into adulthood dates back approximately 4,000 years to our European ancestors and correlates with increased consumption of dairy products into adulthood¹⁴. The terms fructans, galactans and inulins refer to differing length oligosaccharides. Polyols are sugar alcohols, such as sorbitol and mannitol, intrinsic to fruits such as apples, pears, and nectarines and vegetables such as cauliflower and mushrooms. Polyols can also be extrinsically added to processed foods as low-calorie sweeteners.

In several studies, the low-FODMAP diet has demonstrated significant improvement in the symptomatic treatment of IBS patients¹⁵⁻¹⁷. However, long-term adherence to a strict low-

FODMAP is not recommended. The diet is complicated and can severely restrict food choices, especially when combined with other restrictive diets such as a gluten free diet. The goal of the low-FODMAP diet is to adhere to the diet in an effort to reduce symptoms. In individuals that respond to the strict low-FODMAP diet, a step-wise re-introduction of certain foods is undertaken, in an effort to identify their particular food triggers. Only the foods associated with trigger symptoms will need to be avoided long-term. This diet typically requires the oversight from a nutritionist familiar with the diet and its nuances¹⁸. Additionally, a recent small study evaluating the efficacy of dietary FODMAP restriction against standard dietary advice demonstrated similar rates of symptom reduction¹⁹ without the complexities of the low-FODMAP diet.

Mediterranean Diet

The Mediterranean diet is primarily a plant-based diet. The Mediterranean diet emphasizes the consumption of vegetables, fruits, legumes, nuts, and “healthy” fats such as olive oil. There is also a focus on utilizing spices and other seasonings to replace the use of salt. Another important component of the diet is the restriction of carbohydrates from processed foods. In a small study, women reported greater reductions in the desire to eat and sensation of hunger when following the Mediterranean diet compared with men following the same diet²⁰ and this likely may be due to the increased fiber content of this diet. When properly followed this diet is high in intrinsic fiber, low in fat from animal sources, low in carbohydrates from processed foods, and low in salt.

Paleolithic Diet

The Paleolithic diet is based on the principle that humans should consume a diet close to that of their Stone Age hunter-gatherer ancestors. This diet emphasizes the avoidance of all processed foods, the consumption of vegetables, fruits, nuts, seeds, eggs, and lean meats. When properly followed this diet is high in intrinsic fiber, low in fat (typically less than 25% of total daily calories), very low in carbohydrates from processed foods, and low in salt.

Gluten Free Diet

For people with celiac disease, gluten ataxia, and dermatitis herpetiformis the avoidance of dietary gluten is essential for treatment of disease and maintenance of health. Gluten is a soluble complex of proteins found in wheat, barley, and rye. Gluten can also be added to medications as disintegrants, binders, or diluents. In processed foods such as breads, pastas, and pastries, gluten provides structure. There are now gluten free alternatives to use in food production such as flour from rice or corn, which has led to a cornucopia of gluten free processed foods. A common pitfall of this diet is the consumption of large amounts of gluten free processed food sources rather than consumption of fresh vegetables and fruits. In fact, we now are witnessing many celiac disease patients gaining weight while adhering to a gluten free diet, which is a strong indication of the high rates of consumption of these gluten free processed foods.

Organic Foods and Genetically Modified Foods

There are currently few known health benefits to eating organic versus conventionally grown vegetables and fruits²¹. Given the added expense of organic produce and the budgetary limitations of many of our patients, it is much more important that we encourage them to consume more vegetables and fruits rather than subjecting them to the added expense of consuming organically produced foods. At this time, little is known about the health benefits of avoiding genetically modified foods and therefore we will defer making recommendations on these foods.

Dietary Supplements

Since the 1994 passage of the Dietary Supplement Health and Education Act (DSHEA) dietary supplements can be marketed with very little governmental oversight of manufacturing, contents, proof of safety, or proof of efficacy. Each year some dietary supplements are found to contain undeclared active pharmaceuticals such as amphetamines, anabolic steroids and toxins such as heavy metals and bacteria²². The safety for many of these dietary supplements is presumed rather than proven and therefore it is only when these supplements reach the general market that their true dangers are revealed. Recently the weight loss supplement, OxyElite Pro was connected to nearly 100 cases of acute liver injury, three requiring liver transplantation and one resulting in death²³. Dietary supplement contamination with gluten also remains a real hazard for individuals with true celiac disease, gluten ataxia, or dermatitis herpetiformis.

The National Institutes of Health, Office of Dietary Supplements reports that Americans are spending over \$25 billion dollars annually on dietary supplements, including vitamins, minerals, probiotics, fish oils, and botanicals. For the vast majority of individuals without malabsorptive disorders, all nutrients required for optimal health can be easily obtained from a balanced diet. And yet, the majority of the United States population is under-consuming key nutrients such as vitamin D, calcium, potassium, and fiber from their diet, despite overconsumption of daily calories. Even higher rates of vitamin and micronutrient deficiencies are reported in obese individuals compared with normal weight individuals²⁴⁻²⁶, further supporting the fact that these individuals are consuming excess quantities of calorie dense, nutrient poor foods.

Therefore only individuals with documented nutritional deficiencies should be consuming dietary supplements, and when possible these deficiencies should be supplemented through dietary interventions.

Probiotics

There is a lot of excitement surrounding the recent advances in our understanding of the human gastrointestinal microbiome. A brief review of this data will be discussed in the section entitled **THE ROLE OF THE MICROBIOME IN HEALTH AND DISEASE**. However, despite these advances, this field of study remains in its infancy and there are a few cautions we would like to address here in regards to the use of dietary probiotics. 1) The strains typically selected for use in probiotics have not been reliably demonstrated to be key members of the

healthy gastrointestinal microbiota. 2) There are real safety concerns, with a number of documented cases of bacteremia resulting from probiotic strains²⁷. 3) There is a lack of understanding in how these supplemented microbes will affect the intact microbiota²⁸. 4) There are issues pertaining to the quality and viability of the microbes within probiotics. 5) There are concerns with contamination from other pathogenic or antibiotic resistant microbes along with other contaminants such as gluten despite gluten free labeling.

At this time no specific recommendations can be made as to the optimal composition of the human gastrointestinal microbiome. Therefore in the absence of this crucial information and the safety concerns associated with probiotics, we do not broadly advocate for their use.

Cancer Risk

The working group from the International Agency for Research on Cancer (IARC) released a statement in October of 2015, based on a review of 800 epidemiological studies, stating there was an association between the consumption of red and processed meats to the development of cancer²⁹. While the exact mechanism for this association with the development of cancer is currently unknown, this supports the hypothesis that lifestyle choices directly contribute to cancer risk. Obesity has been attributed to approximately 6% of annual incident cancers in the United States³⁰ with higher overall incidence rates reported in obese European women³¹. Obesity remains an important modifiable risk factor for the development of many diseases including certain cancers, diabetes, and cardiovascular disease. Therefore maintenance of optimal body weight must be emphasized as an important component of overall health and disease prevention. And proper food selection and consumption must be highlighted as the foundation for achievement of this goal.

Universal Diet Recommendations

- Consume a diet primarily comprised of fresh vegetables, fruits, and lean protein sources.
 - Increased fiber contributes to greater satiety and improved blood glucose parameters.
 - Lean protein sources also increase satiety.
- Limit intake of processed foods and extrinsic dietary sugars.
- Limit portion sizes.
- Avoid caloric intake from beverages.

A comparison of all the diets reviewed above reveals a central theme; increased consumption of vegetables, fruits, lean meats, and a severely reduced consumption of processed foods leads to positive health benefits which can be applied to a wide range of medical conditions. When implemented properly any one of the reviewed diets will lead to improved health, along with improved cardiometabolic parameters³². The factors driving food choices by most people living in the United States tend to focus on quantity of food and ease of acquisition and preparation, over the content and quality of food. By prioritizing these

factors, the idea that food is the energy source for our body, and therefore an essential component of health, has been sadly lost. This in turn has led to the mass consumption of high calorie, low nutrient quality foods, which is directly contributing to the obesity epidemic.

Studies show that nearly 70% of processed foods contain extrinsic sugars, a trend that has increased over the past few decades³³. During this same time period portion size has increased as has the frequency of snacking, consumption of calories from beverages, and the caloric density of food³⁴. Studies have shown that the calories consumed in sweetened beverages do not lead to a concomitant reduction in calorie consumption from food. Therefore all of these factors have contributed to an increase in total daily caloric intake and concurrent weight gain.

A recent study in children demonstrated that isocaloric fructose restriction leads to improved cardiometabolic parameters in as little as nine days of dietary intervention¹². In this short term intervention dietary sugar was reduced from 28% to 10% of total daily calories and substituted with starch to maintain an isocaloric diet. The children in the study experienced improvements in diastolic blood pressure, LDL cholesterol, glucose tolerance, hyperinsulinemia along with weight loss. Most of the children could not even consume all the food provided by the study as they reported higher rates of satiety¹².

There has also been another unforeseen consequence of the prioritization of prepared foods in the diet that has resulted in the generational loss of food preparation knowledge. Typically food preparation knowledge and skills have been passed between generations, with children growing up with the skills to prepare food as their parents and grandparents had. However, now that we have adults with limited food preparation knowledge, and a lack of emphasis on food preparation as a necessary life skill, we have for the first time a generation that does not understand the important link between food consumption choices and health or the skills necessary to implement this knowledge.

Because lack of time is cited as the greatest barrier to healthful food preparation², we must strive to emphasize the importance of proper nutrition for health and we must provide our patients with simple guidelines on proper nutrition, rather than focusing on specific diet recommendations unless medically indicated.

It would be interesting to evaluate if larger scale interventions such as online classes focusing on simple, healthful food preparation combined with an emphasis on the health benefits of proper nutrition could help affect changes in food consumption patterns. Furthermore, a major limitation of food and nutrition related studies is that they are often sponsored by the major producers of processed food products, the exact products we need to encourage less consumption of.

The Role of the Microbiome in Health and Disease

The human body is colonized by microbes on the majority of surfaces that are topologically connected to the outside environment; including the skin, respiratory tract, gastrointestinal tract and the vagina. Over the past decade there has been an explosion of interest in

understanding the structure, function, and ecology of the human microbiome. The aspirations of this research are to use this information to clinically diagnose disease states and eventually intelligently modify microbial communities to improve human health. While progress has been made in certain areas, we are a long way from achieving these goals.

Microbial community structure is determined by the physical environment (such as the availability of nutrient sources, temperature, or presence of O₂) and interactions between community members (such as antibiotics, and intercellular communication). Therefore it is not surprising that microbial communities vary drastically along the length of the gastrointestinal tract, and that mucosally adherent microbial communities differ significantly from the luminal bulk and stool communities^{35,36}.

As physicians we recognize that most nutrient processing and absorption occurs within the small intestine and that many disease states such as celiac disease, IBS symptoms triggered by food consumption, and inflammatory bowel disease affect different areas along the length of the gastrointestinal tract. Therefore it becomes necessary to directly interrogate the gastrointestinal microbiota from these specific regions. Unfortunately the vast majority of work investigating the human gastrointestinal microbiome has been performed using stool samples. Several studies have shown that stool is an inadequate proxy for the entire gastrointestinal tract^{35,36} and clearly not sufficient to understand the system as a whole.

A small prospective, cross-over study evaluated the effects of diet on the stool microbiome and demonstrated that switching between a vegetarian diet and animal based diet rapidly changes the composition of the stool microbiome³⁷. Unfortunately this study did not adequately control for the dramatic changes in fiber content that occurred with the particular dietary interventions. The fiber content of the vegetarian diet was 25.6 g fiber/1,000 kcal compared with 9.3 g fiber/1,000 kcal in the baseline diet and nearly zero grams of fiber with the animal based diet. The observed changes in microbial community structure could be explained by the simple modification of dietary fiber content, as it is known that different microorganisms ferment different nutrient sources. Furthermore this study was limited in that it only evaluated the stool microbiome and did not investigate the microbiome of the mucosally adherent or luminal microbial communities along the length of the gastrointestinal tract.

Currently the vast majority of gastrointestinal microbiome studies suffer from similar limitations that make it very difficult to distinguish between correlation and causation. Carefully controlled studies coupled with proper sampling are needed to address the complex interactions between the microbiome and human health and disease.

An excellent example of effective therapeutic microbial community modulation is that of fecal microbiota transplant for the treatment of *Clostridium difficile* colitis. Studies have shown that fecal microbiota transplant is an effective and safe treatment for recurrent and refractory *Clostridium difficile* colitis³⁸, and emerging data suggest it may also be effective in select patients for the treatment of toxic megacolon³⁹. To date fecal microbiota transplant has not demonstrated efficacy for the treatment of other disease states such as inflammatory bowel disease or IBS. However, these treatment failures may be reflective of the source of

the microbial communities being transplanted rather than the true efficacy of the treatment in these particular disease states.

Conclusion

Food is literally the fuel for our bodies and it is important that we recognize the effects that food choices have on overall health expectancy and life expectancy. Currently two-thirds of the adult population within the United States is classified as overweight or obese and this is a direct consequence of changing food consumption patterns. With the over consumption of calorie dense, nutrient poor foods there has been a paradoxical development of nutritional deficiencies in the face of calorie excess, a phenomenon that has never been witnessed before. Historically nutritional deficiencies were only observed in cases of food instability that included calorie and protein malnutrition or diseases of malabsorption. However, now with less than 20% of individuals consuming a healthful diet, an emerging epidemic of vitamin and micronutrient deficiencies is again arising in the United States.

Furthermore, there are increasing rates of diseases including metabolic disorders, cardiovascular disease, and certain cancers that are directly attributable to obesity. Epidemiological data reports higher rates of cancer for obese women compared with normal body weight females. And a recent large-scale cohort study which followed 1.3 million individuals for 30 years demonstrated that even aerobic fitness cannot completely mitigate the risk of early death due to obesity⁴⁰.

As physicians we are obligated to provide our patients with consistent, easy to understand dietary recommendations to promote health. Therefore, we are advocating for a simplification of dietary recommendations that include the following components; 1- focus on consumption of primarily fresh vegetables and fruits, 2- consume reasonable amounts of lean proteins, 3- minimize consumption of processed foods, 4- avoid consuming calories from beverages, and 5- limit portion size.

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Key Points

- Diet is a risk factor in a number of medically important disease states: obesity, celiac disease, and functional gastrointestinal disorders.
- Modification of diet can prevent, treat, or alleviate some of the symptoms associated with these diseases and improve general health.
- It is important to provide patients with simple dietary recommendations in order to increase the probability of successful implementation.
- Women can play an important role in maintaining family health by making more informed dietary decisions.
- The gut microbiome may play a role in some gastrointestinal disorders. however better designed studies are required to differentiate correlation from causation in this emerging area.

Table 1
Comparison of current dietary trends

DIET	MAJOR PRINCIPLES	MAJOR PITFALLS
LOW-CARBOHYDRATE	Adherence to a diet low in total daily calories from carbohydrates, typically less than 45%. With concomitant total calorie reduction. Limitation of carbohydrates from processed foods.	Excess consumption of calories from fat. Failure to reduce overall calorie consumption. Failure to reduce carbohydrate consumption from processed foods.
LOW-FAT	Adherence to a diet low in total daily calories from fat, typically less than 20%. With concomitant total calorie restriction.	Excess consumption of calories from processed foods. Failure to reduce overall calorie consumption.
LOW-FODMAP	Attempt to identify food triggers for IBS patients. Short-term avoidance of foods high in FODMAPS, followed by step-wise reintroduction of certain food groups. Long-term avoidance of identified food triggers.	Difficulty with implementation. Difficulty with food re-introduction. Requires assistance from a nutritionist. FODMAPS may not be source of symptoms. Reduction in FODMAPS may not improve metabolic parameters.
MEDITERRANEAN	Consumption of vegetables, fruits, legumes, nuts and olive oil. Limitation of processed foods, meats, dairy.	At times complicated to follow as available information varies on what foods are part of this diet.
PALEOLITHIC	Avoidance of processed foods. Consumption of vegetables, fruits, nuts, seeds, eggs, lean meats.	Requires knowledge of food preparation.
GLUTEN FREE	Appropriate for treatment of celiac disease, dermatitis herpetiformis and gluten ataxia. Avoidance of gluten containing foods.	Excess consumption of calories from gluten free alternative processed foods. No specific recommendations to limit consumption of processed foods. No specific recommendations about limiting fat consumption or dairy consumption. No specific recommendations advocating for consumption of vegetables fruits, or lean meats.
UNIVERSAL DIETARY RECOMMENDATIONS	Prioritize the consumption of vegetables, fruits, lean meats. Limit consumption of processed foods and dairy products. Intrinsic fiber content in foods leads to improved metabolic parameters and satiety. Consumption of lean protein sources aid in satiety.	