Annual Scientific Review of Ultra-Processed Food, Dietary Patterns, and Chronic Disease and Dietary Guidelines for Texans

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Executive Summary

The Texas Nutrition Advisory Committee (TNAC) was established by Senate Bill 25, 89th Texas Legislature, Regular Session, 2025, to conduct an independent review of the scientific evidence regarding nutrition, dietary patterns, ultra-processed food (UPF), and chronic disease, and to develop dietary, educational, and public health recommendations for Texans. This report reflects the work of the seven-member committee, supported by extensive engagement of volunteer subject matter experts from across Texas representing medicine, nutrition and dietetics, public health, agriculture, education, and community organizations. The first annual report fulfills the Committee's legislative charge by reviewing current evidence, identifying areas of scientific consensus and uncertainty, and providing practical guidance to inform future educational and public health efforts.

Defining Ultra-Processed Food

The TNAC recognizes that definitions of UPF continue to evolve. Current scientific literature most commonly uses the NOVA classification system, though federal agencies and independent expert groups are actively developing updated frameworks. Future Texas efforts should continue to follow emerging federal definitions and evolving scientific consensus while recognizing important distinctions among food processing, packaging, food additives, nutrient quality, and overall dietary patterns. The TNAC notes that not all UPF carries equivalent nutrition or health implications, and that dietary quality is an essential consideration alongside processing classification.

Independent Review of Scientific Evidence

The TNAC reviewed current evidence examining relationships among dietary patterns, ultra-processed food, and chronic disease outcomes across the lifespan. The evidence demonstrates that dietary quality remains an important determinant of health and chronic disease risk.

Across multiple health outcomes, strong evidence suggests that higher-quality dietary patterns characterized by vegetables, fruits, legumes, whole grains, nuts and seeds, healthy fats, and minimally processed foods are associated with lower risk of chronic disease and premature mortality. Dietary patterns with these nutrient-dense foods consistently demonstrate favorable associations with cardiometabolic health and overall longevity.

Evidence regarding UPF continues to evolve. The TNAC found that higher consumption of UPF is generally associated with poorer dietary quality and adverse health outcomes. Fair evidence suggests associations between higher UPF intake and increased risk of all-cause mortality and cardiovascular disease mortality. Evidence also shows associations with obesity, type 2 diabetes mellitus (T2DM), cardiovascular disease, mental health outcomes, and other chronic conditions, although the strength of evidence varies by outcome. The full report details the strength of current evidence.

The TNAC also identified important scientific uncertainties. Significant gaps remain regarding mechanisms through which UPF may influence health, including effects on the gut microbiome, inflammation, metabolism, maternal-fetal health, neurodevelopment, reproductive health, and potential epigenetic pathways that may influence future generations. Evidence is particularly limited for children, pregnancy, perimenopause, older adulthood, and populations at elevated metabolic risk.

Developing Dietary Guidelines

The TNAC reviewed current federal dietary guidance, professional society recommendations, and international dietary guidelines. Across these sources, several consistent themes emerged:

- Emphasize vegetables, fruits, legumes, whole grains, nuts, seeds, herbs, and spices.
- Choose nutrient-dense, whole food sources of protein and healthy fats.
- Limit UPF in an overall dietary pattern.
- Support balance, variety, and enjoyment of food.
- Adapt healthy eating patterns to individual culture, preferences, life stage, and health needs.

Based on the detailed literature review described in the report and lessons learned from other guidelines, the TNAC recommends the following Dietary Guidelines for Texans.

Dietary Guidelines for Texans

Foods without a lot of processing are best for your body.

These guidelines include examples of healthy foods. Many foods not listed here may also be great choices.

Foods in their original form, like they are found in nature, form the basis for health.

Eating well means eating healthy food most of the time, food from each group, and enough to meet your needs.

- Fill half your plate with vegetables and fruit at every meal for better digestion and health.
  - Choose a variety of colors such as red/pink (beets, radish, tomatoes, strawberries, apples, grapefruit, red peppers); orange/yellow (carrots, squash, pumpkin, sweet potato, peaches, cantaloupe); green (spinach, asparagus, broccoli, okra, cucumbers, pears); blue/purple (cabbage, berries, plums); white (cauliflower, potatoes, onion)
- Eat three or more servings of healthy proteins each day to keep your muscles, brain, bones, and skin strong.
  - Healthy proteins are unprocessed or minimally processed. This means they are close to how they are in nature—avoiding added ingredients, such as preservatives.
  - Beans, peas, lentils, seafood, poultry, beef, pork, lamb, wild game, eggs, nuts, and seeds are all good ways to get protein.
- Include healthy fats every day.
  - Some sources of healthy fats include nuts, seeds, fatty fish, olive oil, and avocadoes.
- Eat food for healthy bones and teeth every day.
  - Foods that help keep bones healthy include those with protein, calcium, vitamin D, vitamin K, and magnesium.
  - Foods that have these nutrients include:
    - Unflavored dairy foods with no sugar added: whole fat or low-fat milk, kefir, yogurt, and cheese.
    - Non-dairy foods: fatty fish with bones like jarred/canned salmon or sardines, tofu, fortified soy or other plant-based milk, okra, green cabbage, broccoli and leafy greens (kale, mustard greens, collards, bok choy, turnip, dandelion), beans (black-eyed peas, soy, white, navy, great northern, garbanzo), seeds (sesame, chia, flax, poppy, hemp), nuts (almonds, Brazil, hazelnut)
- When you choose grains, choose whole grains.

    - Whole grains are unprocessed or minimally processed. That means they are close to how they are in nature. They do not have lots of added ingredients like preservatives.
    - Whole grains include brown rice, corn, barley, buckwheat, millet, quinoa, whole oats, whole wheat, farro, and others.
- Drink water when you are thirsty.
    - If you drink tea or coffee, consider reducing or avoiding sugar, sugar substitutes, or artificial creamers.
    - There is no safe amount of alcohol. Consider reducing or avoiding alcohol.

How you prepare your food matters.

- Make your own food to save money and have more control over what is in it.
- Prepare food simply using spices and herbs to make it taste better and help prevent disease. Limit excess sugar, fat, and salt.
- Bake, broil, roast, poach, lightly sauté, stir-fry, or steam your food to keep the nutrients in them.
- Smoking, frying, and grilling can create substances in your food that can be harmful to your health. Use these cooking methods less often.
- When buying food in packages, jars, cans, or boxes, look for items without many added ingredients.
    - Frozen, jarred, or canned produce without added coloring, preservatives, salt and sugar are good choices.
    - UPF are foods made in a factory that are less healthy. They may have excess fat, sugar, salt, and ingredients like artificial colors, flavors, and sweeteners. Choose these less often.
- Avoid heating food in its packaging (plastic).

There are many ways to eat healthy.

- Many patterns of eating can be healthy. Find healthy foods that fit your culture, budget, and likes.
- Traditional diets, with foods like seafood, vegetables, fruits, whole grains, and healthy fats, help maintain health and prevent chronic disease.
- Eating mostly minimally processed plant foods is another way to stay healthy.

- Foods from animals like unprocessed or minimally processed meat and dairy can be part of a healthy diet. Balance them with plenty of high fiber foods like vegetables and fruits.

Figure 1. This visual developed by the TNAC was informed by a review of the scientific evidence, existing national and international dietary guidance patterns, and emerging scientific literature on dietary quality, chronic disease prevention, and metabolic health.

The image is intentionally designed to represent a wide variety of foods and dietary traditions commonly enjoyed across Texas communities, including foods rooted in diverse food cultures. It is not intended to represent every food or dietary pattern, but rather to illustrate how many different whole and minimally processed foods can fit within a balanced dietary pattern.

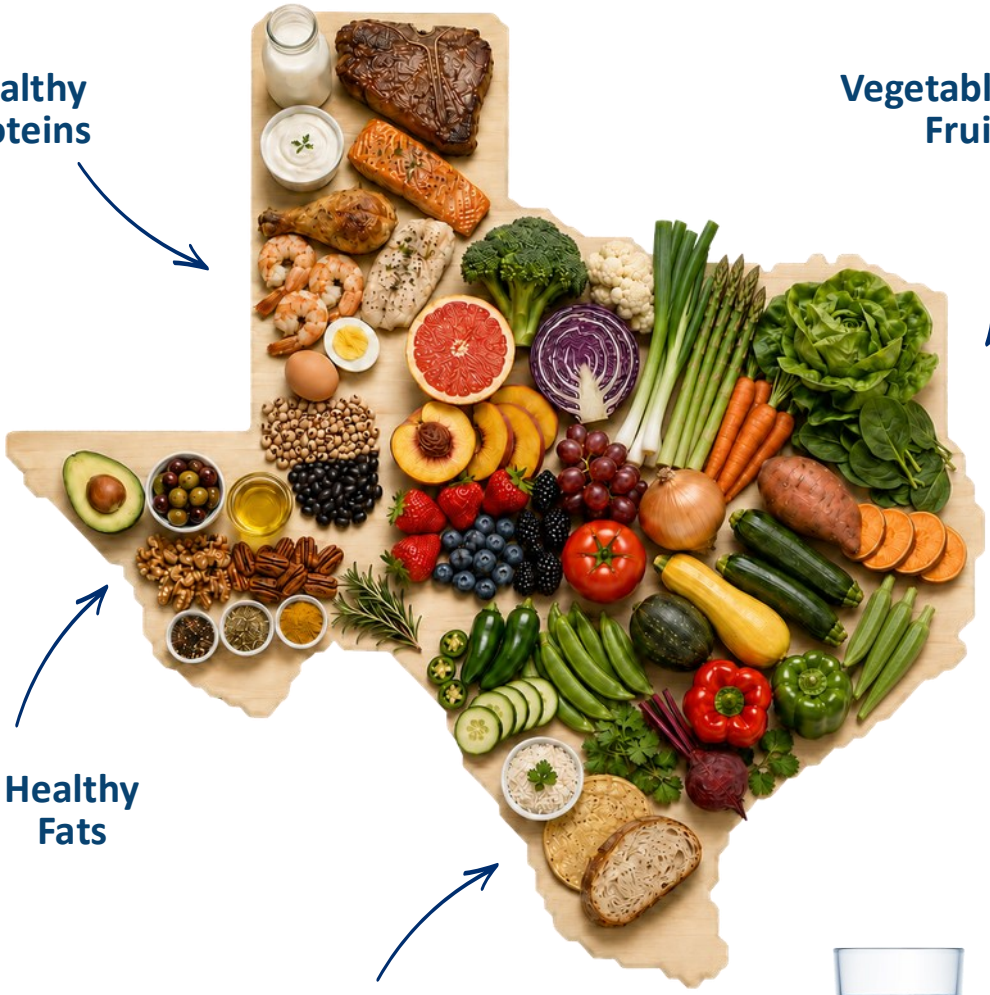
The visual is intended to be consistent with the 2025-2030 Dietary Guidelines for Americans (DGA) graphic, including the same food groups to avoid confusion. This visual separates protein, dairy, and healthy fat into three distinct groups: healthy proteins, dairy, and healthy fats to note the differences in the types of foods in each group. The food groups are placed in a similar location as they are placed on the DGA graphic.

Each food group emphasizes whole foods, including both animal and plant foods grown, caught, and raised in Texas. The healthy proteins group includes seafood, beans, black-eyed peas, chicken, eggs, and beef. The dairy group includes milk and plain yogurt. The healthy fats group includes pecans, peanuts, oil, and avocado. The vegetables and fruits group includes a variety of brightly colored plants including green, red/pink, white, orange/yellow, and purple/blue foods. The whole grains group includes unprocessed foods such as brown rice and oats, as well as products made from minimally produced grains such as corn tortillas and whole grain bread. Water is shown as the primary fluid source for Texans.

The Texas-shaped plate is intentionally not filled completely. This reflects the concepts of balance, moderation, and mindful eating, including observations from longevity research suggesting potential benefits associated with avoiding overconsumption and eating until comfortably satisfied rather than overly full.

The TNAC recognizes that the evidence review process is ongoing and iterative. This visual illustrates core Texas dietary guidance principles and communicates healthy eating patterns in a way that feels culturally relevant, practical, flexible, and uniquely Texan.

EAT REAL FOOD, Y'ALL



Choose water to drink

Dietary Guidelines Framework

Recognizing that food decisions occur within real-world circumstances, the TNAC developed a practical framework to help Texans translate dietary guidance into everyday life. The framework emphasizes five factors that influence food choices.

Figure 2: This graphic illustrates the five ways Texans can filter the dietary guidelines based on their access, time, skills, meaning, and needs related to food.

From Guidelines to Real Life

Many pathways. One goal: helping Texans nourish themselves in ways that are feasible, meaningful, and supportive of long-term health.

FIVE FILTERS OF REAL LIFE

TEXAS DIETARY GUIDELINES

Science-based evidence on healthy dietary patterns

1. ACCESS
Food availability and affordability, impacted by geography, transportation, housing, finances, and circumstances.

2. TIME
Work and school schedules, caregiving responsibilities, and many other demands on time.

3. SKILLS
Cooking confidence and equipment; food storage and strategy, meal planning, and minimizing waste.

4. MEANING
Food relationship, culture, family practices, preferences, religious beliefs, celebrations, enjoyment, and the social role of food

5. NEEDS
Medical conditions impacted by food (including allergies and medications), life stage (growth, pregnancy, aging), and physical activity

MULTIPLE HEALTHY PLATES

Different lives.
Different choices.
All can align with healthy dietary patterns.

ONE GOAL

Health, well-being, and quality of life for all Texans.

Individuals make food choices within their realities. Communities, organizations, healthcare systems, schools, employers, and policymakers also play a vital role in creating environments that support healthy eating.

The TNAC encourages nutrition educators, healthcare professionals, community organizations, and policymakers to consider these factors when supporting dietary change. While science identifies dietary patterns associated with better health outcomes, there is no single eating pattern that is appropriate for every Texan. Multiple pathways can support healthy eating. The TNAC also notes population-specific considerations, including evidence supporting dietary patterns that promote healthy aging and cognitive health among older adults.

The TNAC also recognizes that many Texans face practical barriers to healthy eating, including food insecurity, transportation limitations, affordability challenges, time constraints, and geographic differences in food access. Improving dietary quality requires individual knowledge, skills, and supportive environments that make healthy choices feasible. Schools, healthcare systems, food assistance programs, community organizations, agricultural producers, retailers, and policymakers each play an important role in improving access to nutritious foods across Texas.

Education Recommendations

Nutrition knowledge and food skills are most effective when reinforced throughout the lifespan and integrated into existing educational environments with flexibility.

Across K–12 schools, career and technical education programs, colleges, and universities, successful nutrition education approaches share common characteristics:

- Integration into existing learning environments rather than reliance on standalone programs.
- Reinforcement through experiential and practical learning opportunities.
- Support from trained educators and institutional leadership.
- Adaptation to local community needs and resources.
- Partnerships among schools, healthcare organizations, agricultural stakeholders, and community organizations.

The TNAC recommends continued development of evidence-informed educational resources that can be shared broadly across Texas. Consideration should be given to grant-supported mechanisms that encourage development, evaluation, dissemination, and implementation of high-quality nutrition education tools and curricula.

Health Professional Education

Nutrition and metabolic health are central to prevention and management of many chronic diseases. The TNAC recommends continued integration of nutrition education across nursing education, medical and advanced practice education, graduate medical education, and continuing professional education.

Emphasis should be placed on helping future health professionals translate nutrition knowledge into patient care through screening for nutritional risk, basic nutrition assessment and education, providing support for behavior change, interdisciplinary collaboration, and community resource awareness.

Texas medical schools and training programs are encouraged to align nutrition education efforts with emerging national best practices while maintaining flexibility to address local needs. Collaboration among Texas institutions may help reduce duplication of effort and accelerate implementation of effective approaches.

Public Health Communication and Food Environment Strategies

Effective nutrition communication should be practical, evidence-informed, understandable, culturally relevant, and adaptable to diverse populations. Public health messaging should focus on helping Texans understand how dietary patterns influence health while providing realistic strategies that fit everyday life.

The TNAC recognizes that food choices occur within broader social, economic, cultural, and community contexts. Individuals make food decisions daily, but food environments must be designed to support healthy eating. Evidence suggests that associations between UPF intake and cardiometabolic risk may emerge early in life, highlighting the importance of environments that support nutrition across childhood and adolescence.

The TNAC identified several areas for continued discussion and evaluation, including:

- Information environments that help consumers make informed decisions.
- Food access and affordability.
- Availability of nutrient-dense foods in community settings.
- Support for local and regional food systems.
- Nutrition education at points of access and assistance.
- Opportunities to align agricultural, economic, educational, and health priorities.

Overall, the TNAC supports public health approaches that make whole, nutrient-dense food easier for Texans to access, understand, and incorporate into daily life.

Research Gaps and Future Directions

The TNAC identified substantial opportunities for future research. Although evidence linking dietary quality and health outcomes is robust, important questions remain regarding UPF, mechanisms of disease, vulnerable populations, and implementation strategies.

Priority areas include:

- Mechanistic research to better understand biological pathways linking dietary patterns, food processing, metabolic dysfunction, and chronic disease.
- Texas-specific nutrition and UPF surveillance to better characterize dietary patterns, disparities, and health outcomes within the state's unique populations.
- Implementation science to identify effective and scalable strategies for improving diet quality across healthcare, community, educational, and workplace settings.
- Long-term health outcomes research examining the impact of dietary patterns and reductions in UPF consumption on chronic disease incidence, quality of life, and healthcare utilization.
- Safety of commonly available “wellness” products that are ultra-processed, including those designed for meal replacement.
- Economic analyses evaluating the cost-effectiveness and return on investment of nutrition-related interventions.
- Population-specific research examining differential impacts of dietary patterns across age groups, geographic regions, socioeconomic circumstances, and cultural communities.
- Food safety and food systems research, including evaluation of additives, food packaging risks, ingredient interactions, and cumulative dietary exposures.
- Commercial determinants of health research examining how food environments, marketing, pricing, and availability influence dietary choices and health outcomes.
- Emerging areas of nutrition science, including reproductive health, maternal and child health, cognitive health, healthy aging, microbiome relationships,

epigenetic effects, and precision nutrition approaches (including nutrigenomics and metabolomics).

The TNAC encourages continued support for research efforts that address these gaps and strengthen the evidence base available to policymakers, educators, healthcare professionals, and communities. Opportunities may also exist for Texas to lead collaborative research infrastructure, evidence synthesis activities, innovative strategies to improve dietary patterns, and ongoing monitoring of emerging nutrition science to support evidence-informed policy and practice.

Conclusion

The TNAC 's review found consistent evidence that dietary quality is strongly associated with health outcomes across the lifespan and that dietary patterns emphasizing minimally processed, nutrient-dense foods are associated with lower risk of many chronic diseases. Evidence regarding UPF continues to expand and suggests adverse health effects, although important scientific questions remain.

The recommendations in this report emphasize practical dietary guidance, lifelong nutrition education, health professional training, evidence-informed communication, supportive food environments, and continued research. Together, these strategies can help Texans make informed nutrition decisions while supporting broader efforts to improve health, reduce chronic disease burden, and strengthen quality of life across the state. Consistent with the evidence reviewed, Texans can improve dietary quality by increasing consumption of nutrient-dense, whole foods and reducing reliance on dietary patterns dominated by UPF.

Introduction

Committee Mandate, Scope, and Composition

The TNAC is charged with collecting and interpreting scientific evidence that will inform the Governor, the Department of State Health Services, and other health and safety committees of nutritional guidelines and educational recommendations in an annual report.

The TNAC objectives:

a) Examine the impact of nutrition on human health including the relationship between ultra-processed food and chronic diseases.

b) Provide an independent review of scientific literature analyzing the effects of ultra-processed food on human health.

c) Develop educational recommendations focused on the effects of ultra-processed food on human health.

d) Recommend dietary and nutritional guidelines based on scientific evidence.

Per the guidance of Senate Bill 25 of the 89th Legislative Session, the TNAC Committee is comprised of seven members appointed by Governor Greg Abbott. The initial appointees were finalized in December 2025 and assigned to serve staggered terms for either two or four years each. The bill stipulated member representation on the Committee TNAC as follows:

1. Expert in metabolic health, culinary medicine, lifestyle medicine, or integrative medicine.
2. Licensed physician certified in functional medicine.
3. Texas Department of Agriculture representative.
4. Rural community member.
5. Urban community member.
6. Pediatrician specializing in metabolic health.
7. General member.

The inaugural committee members reflect broad expertise across medicine (three members, including board certifications in primary specialties of internal medicine and pediatrics with additional training and certifications in functional medicine, lifestyle

medicine, and culinary medicine), nutrition and dietetics (one member), advanced nursing practice (one member), health-related business (one member), and agriculture (one member). As per the bill's requirements, committee members do not have conflicts of interest with food, beverage, pharmaceutical, or dietary supplement companies. Brief biographies of each committee member are available in the **Committee Biographies Appendix A.**

Based on an independent review, the TNAC will develop and maintain nutritional guidelines for Texans that reflect the latest scientific evidence and have practical applicability across a variety of educational settings.

Nutritional guidelines outlined by the TNAC will inform the Texas Medical Board, the Texas Board of Nursing, and the Texas Commission on Licensing and Regulation as they implement mandated continuing education on nutrition and metabolic health as stipulated in Senate Bill 25 of the 89th Legislative Session.

Nutritional guidelines outlined by TNAC will also impact the State Board of Education and Texas Higher Education Coordinating Board as they prepare health and nutrition curriculum for students in K-12 and higher education courses.

Subject Matter Expert Engagement

Due to the scope of the task and need for specialized expertise in evidence review of complex nutrition science as well as stakeholder engagement across the educational spectrum, the TNAC invited collaboration from subject matter experts (SMEs).

Nutrition science SMEs contributed to the report by conducting rapid structured reviews of the scientific literature within assigned topic areas. Using a standardized search strategy developed by TNAC (described in the literature review section with full **Search and Literature Review Strategy** (**Supplement 1**) materials available on request from the Additional Supplementary Resources) the Department of State Health Services Library conducted literature searches by topic area. Due to the rapid timeline for development of the research questions, search strategy, and topic domain areas, the literature searches provided an initial foundation and were not intended to be as exhaustive as would be possible with a typical systematic review timeframe and resources.

SMEs reviewed the provided evidence and incorporated additional relevant studies as appropriate. SMEs were given permission to either add missing studies based on their expertise or to exclude studies from analysis if deemed not relevant to the core research questions for the report. SMEs applied standardized review and grading tools to evaluate the quality and strength of evidence and developed concise written

summaries to inform report sections. All draft content underwent iterative review with final, independent approval by the TNAC during open meetings to ensure accuracy, consistency, and transparency. All reviewed studies are cited in this report in the related topic chapter and included by topic domain in the **Evidence Review and Grading Tables** (**Supplement 2**) of the Additional Supplementary Resources, which are available upon request.

Additional SMEs provided expertise across a range of topics, including provision of educator and learner perspectives given the educational impact of this report and the associated legislative charges. SMEs in school nutrition, the charitable food system, the practice of nutrition and dietetics, and other domains were also engaged.

All SMEs completed agreements denoting their willingness to engage without compensation or benefit and to disclose any potential conflicts of interest. SMEs are formally recognized as contributors (see **Subject Matter Expert Contributor Appendix B** for details on their backgrounds and contributions), reflecting the collaborative, multi-disciplinary input across Texas that informs this report.

Background: Nutrition and Chronic Disease in Texas

Historical Context of Chronic Disease in the U.S. and Texas

The rates of chronic disease[1] and associated healthcare costs[2] in the U.S. continue to rise unsustainably with poor nutrition as the leading cause of mortality and chronic disease suffering.[3]

Children also bear a significant burden of disease, including increasing rates of overweight and obesity, T2DM, elevated blood pressure, metabolic-associated steatotic liver disease, depression, anxiety, and ADHD. The connection between costly chronic disease and dietary quality[4] necessitates efforts to support Texans to increase consumption of food that promotes health and reduce consumption of foods that have potential harmful effects.

Texas is on par with national averages of adults diagnosed with common diet-related chronic diseases, including obesity, T2DM, hypertension, and cardiovascular disease. Obesity rates in the U.S. and Texas (BMI greater than or equal to 30) are on the rise, with a U.S. obesity prevalence of about 42.5%[5] and a Texas obesity prevalence of about 35.6%.[6] Obesity is linked with other chronic diet-related diseases, such as T2DM, with over 80% of people with T2DM being overweight or obese.[7] About 9% of American adults have T2DM, and Texas is ahead of the national average with 12% of Texan adults having diabetes.[8] T2DM-related mortality is higher in rural areas than urban areas[9] and is increasing throughout both urban and rural areas in the U.S.[7] While it is estimated that nearly half of all adults in the U.S. have hypertension,[10] many are unaware of their condition; in the U.S. and Texas, about one third of adults are officially diagnosed with high blood pressure.[10,11] Cardiovascular disease (CVD) is the number one leading cause of death in both the U.S. and in Texas, with heart disease and stroke (both considered part of CVD) accounting for about 30% of deaths in Texas and nationally.[12]

Diet also contributes to cancer risk. About a third of cancers in Texas are caused by modifiable risk factors, with obesity being the second-most leading modifiable risk factor.[13] Obesity is a significant risk factor for cancer throughout the U.S. as well, affecting all sexes, races, and ethnicities.[14] In the U.S., approximately six million people have cancer, and Texas has one of the highest cancer prevalence rates of all

U.S. states, with about 420,000 Texans (1.4% of the population) living with cancer. Dietary patterns high in whole foods, which have been shown to protect against some forms of cancer, include diets with high Healthy Eating Index scores, Mediterranean and vegetarian diets, the Dietary Approaches to Stop Hypertension Pattern (DASH) diet, high Nordic Food index score diets, and some low carbohydrate, high protein diets.[15,16] Consistent with these dietary patterns, the American Cancer Society recommends diets rich in vegetables, fruits, and whole grains, and limited in high processed foods, including processed grains, sugary drinks, and red meats to prevent cancer. As research continues to link dietary patterns with cancer risk, dietary approaches will increasingly emerge as essential to reducing cancer risk.[17]

Dementia prevalence has increased in Texas and the U.S. as the average lifespan increases, with about seven million Americans and 450,000 Texans having Alzheimer's dementia in 2026.[18] There is evidence that maintaining a healthy and produce-forward diet reduces risk for dementia.[19] Notably, having comorbid diet-related conditions such as hypertension and CVD also increases the risk of developing dementia.[20] The Mediterranean diet, DASH diet, and a hybrid of the two diets, the MIND (Mediterranean Intervention for Neurodegenerative Delay) diet, aim to reduce the risk of cognitive decline and developing conditions like dementia. Evidence of the efficacy of these dietary patterns in reducing dementia risk and in slowing cognitive decline during dementia is promising.[21,22] These diets share in common a pattern of high vegetable and fruit intake, healthy fats, and whole grains.

Mental health conditions are a serious problem in Texas as well, with over a million emergency department visits per year in Texas related to mental health conditions.[23] Of these, about 400,000 are due to depression, and almost 600,000 are due to anxiety disorders. In the U.S., about 2.2 million people suffer from depression, and 191,000 of those people are in Texas, with a rate of 36.4 people per 100,000 having depression – just slightly lower than the national rate of 36.7 people per 100,000.[24]

Mental health conditions can be difficult to track, so the reported number of people diagnosed with conditions like depression may be lower than the true number of people living with these mental health conditions. In Texas, 30.4% of people in 2024 reported having poor mental health within the last five days.[23] Depression can be more common in older adults and is associated globally, nationally, and within Texas with having other chronic diseases and poor lifestyle behaviors.[25–27] Healthy diets are associated with reduced risk of developing depression.[28] Conversely, having depression is a predictor of poor dietary quality.[29] The evidence in both of these areas is limited and requires further study.

Texas Food Access, Nutrition, and Health Landscape

There is little evidence specific to Texan dietary patterns. Therefore, they are presumed to reflect typical American dietary patterns, including characteristics of a typical Western diet: high consumption of refined grains, ultra-processed meats, desserts, sugar-sweetened beverages, and fried foods.[29] Because individuals consume combinations of foods rather than isolated nutrients, food-based dietary patterns provide a practical framework for understanding how habitual eating behaviors influence health outcomes.[30] The food environment in which Texans must choose what foods to consume varies widely, especially in rural and border communities, where nutritious food is not always easy to obtain.[31]

In Texas and the U.S., rural areas face greater barriers to accessing healthcare and higher rates of premature mortality when compared with urban areas.[32] These barriers include geographic isolation, lack of infrastructure, and shortages of medical care.[33] For rural Texans, traveling long distances is a barrier to accessing primary care for chronic diet-related disease management. Traveling long distances is more common to address emergencies than for prevention.[34] Rural Texans of Hispanic descent face a greater burden of disease in the state, especially for chronic diseases such as dementia,[35] and Texans belonging to certain groups have greater mortality for the five leading causes of death including stroke and heart disease.[36]

As diet-related chronic disease morbidity and mortality increase in Texas, especially for rural areas, access to fresh and healthy foods is vital to ensure the health of all Texans across the state. Food insecurity, or lack of access to enough healthy and nutritious food, is common in Texas with about one eighth of the state population suffering from food insecurity, the highest rate in the nation.[37] Healthy food access is made more difficult by lack of walkability, poor public transport, and lack of access to transportation.[38] Not all geographic areas have equal access to fresh and healthy foods, with greater distances to travel to obtain healthy foods found in rural areas than urban areas in Texas, and many barriers exist within urban areas as well.[39] Food insecurity worsens in Texas with natural disaster occurrences such as the Texas Freeze of 2021,[40] Hurricane Harvey,[41] and the COVID-19 pandemic,[42] with people having limited transportation or being from higher risk groups, such as college students[43] and teens,[44] being especially affected.

Texas Department of Agriculture Perspective: Supporting Nutrition and Health in Texas

The Texas Department of Agriculture (TDA) is proud to have a seat on the TNAC. We envision a Texas with greater food security for families, a Texas where children and parents learn healthy eating habits early on—habits that can help protect them from disease throughout their lives—and a Texas where rural Texans can receive quality healthcare and vital crisis resources in times of need. We believe profoundly in the principle of Food as Medicine, and we strive every day to Make Texans Healthy Again.

The TDA is a national leader in advancing nutrition, food security, and preventative health initiatives that directly impact the wellbeing of millions of people. Through nutrition assistance programs, school meal administration, local food promotion, grant programs, and public health partnerships, TDA is helping improve health outcomes while supporting Texas agriculture and rural economies.

Food as Medicine

The TDA administers numerous federally funded nutrition programs that collectively provide healthy meals to Texas children, seniors, and vulnerable populations. Working with approximately 3,000 program partners at nearly 28,000 sites statewide, TDA-administered programs serve more than one billion meals annually and utilize more than $200 million in United States Department of Agriculture (USDA) Foods commodities.

These programs include the National School Lunch Program, School Breakfast Program, Summer Food Service Program, Child and Adult Care Food Program (CACFP), Fresh Fruit and Vegetable Program, and Seamless Summer Option. Together, they help ensure that nutritious meals remain available to Texans regardless of income level, geographic location, or season of the year.

For many rural communities, school nutrition programs represent one of the most reliable sources of healthy meals available to children. TDA works closely with school districts to improve meal quality, increase participation rates, and connect schools with Texas agricultural producers whenever possible. These efforts not only improve nutrition outcomes but also strengthen local economies by creating new market opportunities for Texas farmers and ranchers.

The TDA has also made significant investments in promoting locally sourced foods through Farm Fresh initiatives and local procurement programs. By encouraging schools, childcare centers, and community organizations to purchase Texas-grown

fruits, vegetables, dairy products, and proteins, TDA helps increase access to fresh foods while reducing supply chain barriers. These efforts create a direct connection between healthy eating and the state's agricultural economy, ensuring that taxpayer dollars support both nutrition and Texas producers.

According to the 2023 USDA Farm to School Census, 59.8% of Texas schools were serving local foods.[45] Local food expenditures increased from $151.4 million to $253.8 million between 2019 and 2023, and approximately 3.68 million Texas students received local foods at least weekly through school meal programs. Just over 51% of Texas school food authorities reported providing local food education, while nearly 60% reported increased fruit and vegetable consumption among students.

The TDA has actively supported efforts aligned with the national movement toward healthier food choices and preventative healthcare. The Department has consistently emphasized the importance of whole foods, fresh produce, lean proteins, and minimally processed food products in nutrition programs. TDA has placed renewed emphasis on improving food quality and nutrition outcomes throughout the state's nutrition programs because the Department recognizes that improving the quality of food served through public nutrition programs is a critical component of improving long-term health outcomes and reducing the prevalence of chronic diseases such as obesity, diabetes, and cardiovascular disease.

TDA has also championed nutrition education as a critical component of improving public health. Through outreach programs, educational materials, producer engagement, and partnerships with schools and community organizations, the Department helps Texans better understand the relationship between diet, physical activity, and chronic disease prevention. These efforts are particularly important in rural communities, where rates of obesity, diabetes, heart disease, and other nutrition-related health conditions often exceed statewide averages.

Food Security and Healthy Communities

The Texas Department of Agriculture's commitment to nutrition extends beyond meal programs. Through Texans Feeding Texans and partnerships with food banks and community organizations, TDA helps increase access to nutritious foods in underserved and food-insecure communities. The state's agricultural surplus grant program purchases and distributes nearly 60 million pounds of produce annually through food banks and charitable organizations across Texas.

TDA also administers the Home-Delivered Meals Grant Program, partnering with more than 130 local organizations to support homebound seniors. Through this program,

local providers serve more than eight million meals annually that meet federal Reference Daily Intake nutritional standards. In addition to providing nutritious meals, these organizations offer daily wellness checks and regular social interaction that help combat isolation, support independent living, and improve quality of life for older Texans.

These efforts reflect a simple but important principle: healthier Texans begin with better access to healthier food.

Rural Health and Preventative Care

These nutrition-focused initiatives directly complement the mission of the State Office of Rural Health (SORH), which is housed within the Texas Department of Agriculture.

Texas has 254 counties, 202 of which are designated as rural. Through state and federal grants, technical assistance, and healthcare partnerships, SORH works to sustain healthcare delivery systems and improve access to care in rural communities. Programs such as the Capital Improvement Program help rural hospitals make critical facility enhancements, improving health outcomes now and in the future.

While SORH works to strengthen healthcare infrastructure and improve access to care, TDA's nutrition programs help address many of the root causes of poor health outcomes. Together, these efforts create a more comprehensive approach to improving quality of life for rural Texans by combining access to healthcare services with access to nutritious foods, nutrition education, and healthier lifestyle opportunities.

Mental Health and Rural Resilience

The Department recognizes that complete health is not limited to healthy bodies. Healthy communities require strong social connections, access to support services, and attention to mental wellbeing.

Commissioner Miller has made producer mental health a priority through the creation and support of the AgriStress Helpline, a confidential resource available to farmers, ranchers, agricultural workers, and their families. The helpline connects callers with trained professionals who understand the unique challenges facing agricultural producers, including drought, natural disasters, market volatility, labor shortages, rising costs, and geographic isolation.

By connecting producers with trained support professionals and crisis resources, AgriStress helps bridge gaps in care, reduce stigma, and ensure that rural Texans know they are not facing life's challenges alone.

Looking Forward

As Texas continues implementing the Rural Health Transformation Program and pursuing the goal of Making Rural Texas Healthy Again, opportunities exist to further integrate healthcare, nutrition, agriculture, and community-based prevention efforts.

TDA is uniquely positioned to help strengthen partnerships between schools, healthcare providers, food banks, agricultural producers, and community organizations. Continued expansion of Farm Fresh initiatives, nutrition education efforts, local food procurement programs, rural healthcare partnerships, and Food as Medicine strategies can help improve health outcomes while creating new opportunities for Texas agriculture.

By aligning healthcare delivery with nutrition-focused initiatives, Texas can help build healthier communities, reduce chronic disease burdens, strengthen rural economies, and support the agricultural producers who feed our state and nation.

Through these efforts, TDA continues to demonstrate that agriculture and public health are closely connected, and that Texas agriculture is uniquely positioned to help Make Texans Healthy Again.

Supports for and Barriers to Dietary Change

Many factors must be considered that can support dietary change in Texas and reduce barriers. The social ecological model (SEM) provides a way of understanding how individual, interpersonal, and environmental factors may affect health behaviors such as dietary choices.[46] Individual factors affecting diet may include a person's socioeconomic status, food security level, education level, and nutrition knowledge and cooking skills, or food literacy.[47] Inter-personal factors affecting intake include family meals and traditions, and presence or absence of social support for change. Community factors such as the availability of healthy foods, access to transportation, cost and affordability of foods, and cultural norms can also influence food choice. Organizational factors include availability of healthy foods at work, in schools, after school programs, nursing homes, and hospitals.

Among the barriers to all Texans having a healthy diet is food insecurity,[37] meaning that many Texans have limited money to spend on food and may choose cheap, ultra-processed foods over higher quality foods due to perceived cost barriers. Lack of knowledge of healthy foods or how to prepare them can also limit healthy food choices. For many individuals, the food environment encourages ultra-processed food consumption and may not facilitate access to healthy food.[31,48] For others, barriers to

healthy dietary change include geographic location,[39] with rural areas, border communities, and poorer parts of cities having low geographic access to fresh foods[31] and transportation insecurity, which decreases access to grocery stores.[38] Natural disasters,[41] infrastructure challenges,[40] and low socio-economic status[39] are also barriers to increasing healthy food consumption. These same barriers follow the lines of health disparities in Texas and lower access to healthcare to manage chronic, diet-related conditions.[35]

To meet challenges such as perceived affordability of healthy foods, with whole foods such as fruits and vegetables costing more per calorie than ultra-processed food such as those with added sugar,[49] incentivizing healthy food purchases through programs such as SNAP (Supplemental Nutrition Assistance Program) Double Up Food Bucks Texas are effective ways to increase produce consumption in the U.S.[50,51] To address time barriers to preparing healthy meals,[52] nutrition education, including cooking skill development, is one important strategy. Many Americans report not having time to prepare healthy meals for themselves and their households, and this is most concentrated in women, who often bear a larger share of food preparation labor in households.[53,54] Improving cooking skills among all Texans can make cooking tasks faster and easier for families to sustain.

Texas is also extremely culturally and linguistically diverse with a population of 32.3 million people. It is the second-most diverse state in the U.S., the third most linguistically diverse state, the fourth most socioeconomically diverse state, and the sixth most culturally diverse state.[55,56] Therefore, healthy dietary recommendations need to be tailorable to different cultural dietary patterns, which is possible and encouraged using adaptable diet principles of promoting produce, whole grains, lean proteins, and healthy fats, a pattern common to the Mediterranean diet and other dietary patterns.

To improve healthy food consumption, Texans need nutrition education to improve their food literacy and greater public health awareness of the links between healthy food access, dietary patterns, and chronic disease outcomes. This report is an important step in Texas undertaking that public health awareness campaign.

Economic and Healthcare System Implications of Dietary Patterns

The Cost of Food & Diet-Related Disease

According to a recent analysis by the Rockefeller Foundation, Americans paid $1.1 trillion for food at checkout in 2019.[57] Yet, buried beneath sticker prices were additional, "hidden" costs not typically accounted for. These include downstream costs to human health, the environment, and the economy in the form of lost economic activity, disability, and agricultural subsidies. Nationally, the "true cost" of food in the U.S. was estimated to be $3.2 trillion in 2019.[57]

Diet-related chronic diseases present an enormous cost to the American healthcare system, with an estimated 90% of the $4.3 trillion per year spent on chronic disease healthcare in the U.S. being attributable to diet-related disease costs.[58] The state of Texas mirrors this national pattern. In Texas, Medicaid costs related to diabetes, obesity, and cardiovascular disease are the most visible costs, but they sit atop a far larger burden borne by Texas employers, taxpayers, and communities bearing higher chronic disease burden.

A 2024 actuarial analysis commissioned by the Episcopal Health Foundation estimated that Texas Medicaid spent between $6.2 billion and $8.1 billion on adult beneficiaries with T2DM alone in fiscal year 2021, roughly 16% to 21% of total Medicaid medical benefits spending, and 23% to 30% of adult Medicaid spending in the state.[59] Texas adult Medicaid beneficiaries with diabetes incurred healthcare costs about 2.6 times higher than the general adult Medicaid population, and an additional $6.5 to $7.4 billion in Medicaid spending was attributable to obesity, prediabetes, and gestational diabetes. Cardiovascular disease, the leading cause of death in the state, drives a parallel and overlapping cost burden: hospitalization charges for heart disease and stroke in Texas reached $33.5 billion and $9.6 billion respectively in 2023 alone,[60] and Texas's age-adjusted cardiovascular mortality rate (674.1 per 100,000) exceeds the national average.[61]

Beyond Medicaid, diet-related disease taxes the Texas economy through workforce losses, reduced earnings, and absenteeism. An industry-supported analysis estimated that obesity and overweight reduced Texas economic activity by $39.8 billion in 2022 (about 1.7% of Texas' 2022 gross domestic product), which included roughly $8 billion in lost economic activity from 249,000 fewer adults in the workforce, $7.7 billion in reduced earnings for women with obesity, and $4.1 billion in absenteeism and disability costs (averaging $839 per employed adult with obesity).[62] A separate, state-

level analysis estimated a 104.9% increase in individual-level medical expenditures attributable to obesity in Texas, one of the highest among the most populous states.[63] These productivity and economic losses fall on Texas employers, workers, and the broader tax base regardless of payer, but they remain invisible in any analysis that looks at Medicaid spending alone.

The hidden costs of diet-related disease are not distributed evenly across Texas. Geographic analyses identify the south, southwest, and panhandle regions of Texas, including many rural counties, as having the highest prevalence of diabetes and obesity in the state.[64] These disparities translate into compounded costs: communities that are already facing lower food access and dietary quality and reduced access to preventive care are also bearing the heaviest burden of preventable, diet-related disease.

The Potential Economic Impact of Improving Dietary Quality among Texans

It is uncontroversial that the health of Americans and Texans is in a state of crisis. Multiple governmental and private efforts to educate the public on the need for a healthy diet and increased physical activity have been ineffective at significantly improving the quality of diets or activity levels. Rates of obesity and chronic disease continue to rise. Yet there are several approaches that research has shown to be effective at improving health. In addition, there are other policy changes that have potential to improve health. Initiatives and policy changes with potential broad economic impact including funding Food is Medicine (FIM) programs; providing broader access to medical nutrition therapy (MNT); providing nutrition education in schools (K-12), universities, and across healthcare professional curricula; and improved access to healthy foods in institutional settings.

FIM interventions have the potential to be cost-effective and cost-saving for diet-related diseases. A Tufts University microsimulation found that medically tailored meal coverage for 6.3 million Medicare, Medicaid, and privately insured patients with a diet-related condition and a limitation in instrumental activities of daily living would prevent 1.6 million hospitalizations and yield $13.6 billion in first-year healthcare savings ($185.1 billion over ten years).[65] From these findings, Medicaid alone could save $1.6 billion annually, with dual-eligible beneficiaries accounting for $5.7 billion in savings. A 2023 meta-analysis of 81 studies reflecting 60,753 participants similarly found that medically tailored meal interventions significantly reduced hospital readmissions, emergency department visits, and adverse drug events, among other findings.[66] While improvements in clinical outcomes were more consistently demonstrated, findings related to economic outcomes, quality of life, and other patient-centered measures

were more variable across studies, reflecting differences in intervention design, study populations, and outcome measures. The true economic impact of medically tailored meals specifically merits further investigation.

Emerging real-world data from state Medicaid Section 1115 demonstration waivers offer additional insights on the cost-saving potential of FIM efforts.[67] An analysis of Massachusetts's Flexible Services Program (20,403 beneficiaries) showed 23% fewer hospitalizations and 13% fewer ED visits; Medicaid costs were $1,721 lower post-pandemic and $2,502 lower for those enrolled >90 days.[68] North Carolina's Healthy Opportunities Pilot (13,227 beneficiaries) demonstrated that after an initial $687 per-person increase, Medicaid spending declined $85 per person per month.[69]

As of the writing of this report, Texas has not pursued the FIM-specific Medicaid waiver pathway, and Texas-specific real-world data on FIM interventions to-date is limited. The Houston VA Fresh Connect Produce Rx trial is among the first prospective FIM evaluations conducted in Texas.[70] However, outcomes from other states' Medicaid demonstrations,[68,69] combined with Texas-specific simulation results,[71] provide a reasonable evidence base to pilot, expand, or formally evaluate FIM strategies in Texas while being mindful of state specific implementation barriers.[72] Applying true cost accounting[57] to Texas FIM investments such as counting savings to Medicaid, returns to the state economy, and health gains together, would position Texas to make better-informed decisions about a disease burden that is substantial and growing.

Thus, Food is Medicine clinical strategies that provide healthy foods as a treatment to manage diet-related chronic disease could save billions of dollars annually in the U.S. with important impacts in large states like Texas.[73] Broader strategies for nutritional health promotion, such as increasing nutrition education, are harder to measure for their cost-saving effects on chronic disease spending, but they have the potential to reverse the worsening trend of diet-related chronic disease.[74] Preventing chronic disease acquisition or managing and reversing the course of chronic disease through changing one's diet is both a clinically and cost-effective way to reduce chronic disease.

Coverage of MNT is also a policy that has the potential to reduce chronic disease rates. Registered dietitian nutritionists (RDNs) are trained to provide MNT, a therapy that involves nutrition education, counseling, and interventions targeted to prevent or improve a variety of health problems. According to a recent position statement from the Academy of Nutrition and Dietetics that involved an overview of systematic reviews of the literature, high and moderate quality systematic reviews have shown that MNT is likely effective in improving many health outcomes,[75] particularly in adults with pre-diabetes, type 1 and 2 diabetes, obesity, pre-hypertension and hypertension,

dyslipidemia, chronic kidney disease, head and neck cancer, and chronic obstructive pulmonary disease.

With regard to MNT for patients with dyslipidemia, MNT has been shown to save $638 to $1450 per patient per year due to reduced medication requirements.[76] There are limitations to access to RDNs, including lack of comprehensive coverage for MNT by Medicare, Medicaid, and private insurance companies and barriers to referrals by healthcare professionals due to both perceived cost/coverage barriers and lack of enough available RDN practitioners. If Texas became a leader in RDN-provided MNT coverage, these cost savings related to improved health outcomes could be available to many more Texans.

The Texas Senate Bill 25, which established the TNAC, also established that nutrition education will be taught by higher education institutions to students enrolled in medical schools and healthcare professional programs. In doing so, the Texas Legislature has ensured that Texas becomes a leader in nutrition education nationally. Having more healthcare professionals who are well-versed in nutrition has the potential to help more patients access quality nutrition care and for more patients and clinicians to understand the value of MNT when advanced care is needed. However, nutrition education in public schools (K-12) is still optional. Studies to date do not indicate that school-based nutrition education in these grades results in reductions in obesity rates,[77] yet having nutrition education at all levels would better position Texans to prevent health problems across their lifespans.

Finally, a recent report commissioned by the USDA identified policies to reduce reliance among Americans on UPF.[78] Among their key recommendations was to restrict the purchase and procurement of UPF in institutional settings such as schools, early childhood education settings, and government buildings. This, together with ad campaigns against UPF, better front-of-package labeling of UPF, and taxes on some UPF, were suggested as potentially cost-effective ways to decrease reliance on UPF among Americans. Our report, along with the USDA's work, lays the groundwork for how procurement of UPF could be restricted in these settings. To restrict the procurement, UPF must first be identified, which may be done by defining UPF based on ingredient labels. The USDA's report also recommended excluding FDA-defined "healthy foods" from the UPF label as foods that are both "healthy" and are UPF are few. If institutions receiving Texas funding to purchase foods were restricted from purchase of these foods, this would reduce exposure of Texans to foods that may harm their health.

Chronic diseases linked to dietary patterns, including obesity, T2DM, cardiovascular disease, certain cancers, dementia, and mental health conditions, represent a

substantial and growing burden for Texans. The background evidence reviewed in this section highlights the complex relationship between dietary quality, food access, healthcare access, socioeconomic factors, geography, and health outcomes across the state. Texas faces unique challenges related to its size, rural population, cultural variety, transportation barriers, and high rates of food insecurity, all of which influence opportunities for healthy eating and chronic disease prevention. At the same time, nutrition assistance programs, schools, healthcare systems, agricultural producers, community organizations, and local food networks provide important assets for improving nutrition and health. Because dietary habits are established and reinforced across the lifespan, opportunities exist to support healthier eating patterns from childhood through older adulthood. Understanding these factors provides important context for the recommendations presented throughout this report, including the detailed review of scientific evidence connecting dietary patterns and health.

Independent Review of Scientific Evidence

A careful and transparent evaluation of the strengths and limitations of nutrition research is essential when forming public health recommendations, particularly in emerging and debated areas such as UPF.

Interpreting Nutrition Science: Challenges, Limitations, and Key Implications

Understanding nutrition and its impact on human health is essential for directing public health guidance, yet human nutrition is incredibly complex. Not only are foundational disciplines including biochemistry and organic chemistry critical to understanding human nutrition, but one also needs to integrate the key domains of genetics, genomics, microbiology, and human behavior. Human nutrition involves the intake, digestion, absorption, and assimilation of food and the nutrients foods contain. For food and nutrients to affect health, they must first be eaten or, in cases in which eating is impaired, enter the body through artificial means. Consequently, eating traditions and behaviors that inform what humans choose to eat are important components of understanding nutrition. In addition, individuals have differences in digestion, absorption, and assimilation of the nutrients in foods, with these aspects being influenced by genetics, age, life stage, health, and disease.

Laboratory Nutrition Research

Nutrition science relies on many different types of basic research. Cellular, tissue, and animal research is often hypothesis-generating. That is, these types of research allow for controlled study of how particular foods or individual nutrients affect cells or tissues. However, these mechanistic studies that indicate how nutrients or foods may affect cells, tissues, or animals in a particular way do not always indicate the same relationships in human studies. This may occur due to the many complex interactions that occur within the human body and involve not only nutrients and bioactive substances but also the human microbiome, the microorganisms that populate the human body, and individual human genomics.[79] Thus, while cellular and tissue research may help generate ideas about how nutrients work in a particular area of the body, when humans ingest the nutrient, the effects may be different.

Population-Based Research

Studies of populations, also known as epidemiological research, can capture what happens in humans with different patterns of dietary intake over time, allowing for a

better understanding of long-term impacts of intake of foods and nutrients. Yet, because these studies are not controlled and rely on human reporting of their intake, the findings may also be limited.

These population-based studies do not delve into causes of nutritional problems and cannot directly show whether a diet or nutrient improves or worsens human health. Yet, when these studies are well designed and use appropriate tools for dietary assessment and health outcome assessment, they can not only generate hypotheses but can also help to identify potential causal relationships. For example, when studies show larger effects, consistent effects, and there are plausible explanations for a causal relationship, they can build support for a causal relationship between a food, dietary pattern, or nutrient and health or disease.[80]

Randomized Controlled Trials

Randomized-controlled trials (RCT) are a type of research study in which participants are selected at random to receive one intervention or another, and within nutritional sciences, research often involves assignment of one dietary pattern to another for comparison. Researchers try to find similar groups of people and assign individuals randomly to an intervention group (the group that eats a particular diet of interest) or a control group (the group that eats either their usual diet or a diet that is different than the one being investigated). These studies provide a highly controlled type of evidence for the impact of foods or nutrients on health. These types of studies are considered by many to be the "gold standard" of nutrition research because they are carefully controlled. Similar participants (with similar health and personal factors) are compared to one another. Yet, these are expensive, cannot be done for extended periods of time, and may not mimic real-life conditions.

In nutrition research, human RCTs can take several forms. In a controlled feeding trial, researchers provide participants with the food they eat. Because the diet is supplied directly, these trials give the most precise control over what participants actually consume, which yields strong evidence about a diet's effect. However, supplying every participant's food is costly and hard to maintain for long, and the controlled setting may not reflect how people eat outside the study. In other RCTs, participants are instead instructed to follow a particular diet or to eat certain foods on their own, which reflects a more real-world setting but has fewer controls. Behavioral interventions, which support participants in changing how they eat, can also be designed as RCTs. These are valuable, but they are less able to test whether a diet itself works, because participants' eating behavior may not change as intended.

Cross-over RCTs are a unique type of RCT in which participants become their own controls. In a cross-over trial exploring dietary patterns, researchers assign people at random to do one diet or another diet *first*. After the participants eat one diet (either control or intervention), they are next assigned to eat the other. Thus, each participant acts as his/her own control. This form of design is very useful because the sample sizes needed are smaller and the within-between subjects' differences are usually much lower.[81]

While RCTs and cross-over RCTs provide greater insight into whether specific nutrients or dietary factors can impact weight, muscle or fat mass, or biomarkers of disease such as cholesterol levels, glucose levels, or markers of inflammation, they have a limited ability to indicate what long-term effects of dietary patterns will be. Thus, while RCTs may help us understand causal factors in the diet that affect health, they are not ideal for studying the impacts of long-term dietary exposures.

Systematic Reviews, Meta-Analyses, Umbrella Reviews

Nutrition recommendations are informed by a broad body of scientific evidence that includes observational studies, randomized controlled trials, and evidence synthesis methods. Because individual studies may produce conflicting findings or have important limitations, researchers often use structured approaches to evaluate the totality of available evidence, combining findings from many studies to answer specific research questions. Systematic reviews, meta-analyses, and umbrella reviews represent increasingly comprehensive methods for synthesizing research findings and are commonly used to inform dietary guidelines, clinical recommendations, and public health policy. Understanding these approaches provides important context for interpreting the strength of evidence supporting nutrition recommendations.

Systematic Reviews

Systematic reviews are designed to answer a focused research question using a predefined and transparent methodology. Researchers systematically search scientific literature, apply predetermined inclusion and exclusion criteria, evaluate study quality, and synthesize findings across relevant studies. By minimizing bias and considering all available evidence, systematic reviews are often regarded as one of the strongest forms of evidence for informing clinical practice and public health recommendations.

The DGA rely on systematic reviews of the evidence to create new guidelines for how Americans should eat. These guidelines are updated every five years and involve many staff researchers and volunteer consultant researchers. The systematic reviews start

with a research question, which is written in a very specific way. Each research question focuses on a population (P) of interest (such as adults, infants, or children), then looks at a particular nutrition intervention (I) (such as a diet low in UPF or a diet low in carbohydrates or fats), then considers what studies evaluating this intervention have compared (C) it to (for example, the population's usual diet), and finally the impact of the intervention on outcomes (O, such as weight, cholesterol levels, etc.). This is a PICO-formatted question.[82]

After a research question has been generated, librarians or other research staff come up with a search strategy to look through medical databases to find related studies. They use search terms related to the topic to find related studies. They usually limit the search to appropriate years and try to filter out unrelated studies.[82]

After the researchers have identified all articles related to a topic, they read the article carefully. While reading, they use an agreed-on form to extract important information on the study's population, intervention, comparison, and outcomes. They also rate the study for any problems with study design or risk of bias. Bias is just the idea that a study's findings might have errors due to how it was designed.[83]

Next, the researchers summarize all the studies they have found. They identify how large they were, whether findings were positive, negative, or neutral, and what most studies found. Based on this summary, they try to answer the PICO question in simple terms. Then they grade how confident they are in the answer based on how many studies found the same thing, how large the studies were, and how well they were designed.

Meta-Analyses

Meta-analyses also try to answer research questions by reviewing lots of study data. However, instead of combing databases and summarizing findings, researchers identify relevant studies that looked at the same outcomes. Then they combine the actual findings from each study so that the participants in research are combined into one big database.[84] Subsequently, they evaluate the impact of a nutrition intervention on outcomes. While this sounds simple, because studies are done by different groups of researchers, the design can be very different among studies. Thus, finding appropriate studies to include in the same analysis and combining them is challenging to do well.

Umbrella Reviews

Umbrella reviews take the widest review of research. They are like a systematic review of systematic reviews. That is, they take lots of different systematic reviews and meta-analyses, assess how well they are done, and then combine their findings to answer

research questions. Thus, these take the broadest view of research on a question but also may miss important details from individual studies.[85]

Evidence Analysis Process

TNAC Literature Review Process

When the TNAC was formed according to the guidance laid out by the Texas Legislature's 89th session via Senate Bill 25, the timeline to evaluate the evidence about the impact of UPF on the diets of Texans was very short (approximately six months). Systematic reviews, meta-analyses, and even umbrella reviews are all time-consuming, often taking one to three years to complete. They also require expertise that nutrition researchers are most qualified to conduct. Given the diverse and balanced nature of the TNAC's expertise and the lack of funds allotted to answer these important questions, the TNAC decided to engage the vast expertise of many professionals in the state of Texas.

The Academy of Nutrition and Dietetics is the largest association of nutrition professionals in the United States and has international members. In 2004, to help its members sort through and understand all the many different types of nutrition research, the Academy developed the Evidence Analysis Process (EAP). This process uses the steps to conduct a systematic review of the literature and provides tools to do these for nutrition studies.[86] The Academy also asks important nutrition-related research questions each year and then assigns teams of researchers and expert committees to consider and answer these questions. The answers are collected into the Evidence Analysis Library.

We first used a revised version of the Academy's EAP tools to be simpler to apply on an accelerated timeframe. We then developed PICO research questions. We asked the librarians at the Department of State Health Services (DSHS) to conduct literature searches on those questions. Then, we released a call for subject matter expert (SME) volunteers to review those questions and the associated research articles that address them. Each SME group was provided with the articles identified by the librarians and a review of resources developed by the TNAC. They were asked to assess the impact of UPF on the diseases or conditions assigned using the EAP-revised tools. As SMEs, they were invited to add articles that may be missing (noting if they were adding to the original search's articles) and remove articles that were deemed not relevant to the research question (similarly noting the rationale for removal of articles). Finally, they were asked to work on a brief chapter to summarize the impacts of UPF and minimally processed dietary patterns on the particular disease or condition, including what is known and not known about how UPF affects health or disease. Of note, all SMEs

involved in the review process completed agreements with the DSHS indicating lack of payment, coercion, or conflicts of interest. Most SMEs serve as faculty or graduate students in academic institutions across Texas.

Defining Ultra-processed food

History and Framework

Given the growing body of evidence linking dietary patterns high in UPF to chronic disease, establishing a clear and operational definition is essential for research, regulation, and public health guidance. While recognizing and detailing its limitations, this report adopts the NOVA classification as the current standard, while emphasizing that processing alone is not sufficient to define health risk and must be interpreted alongside nutritional quality and context.

"Westernization" of diets has long been associated with higher rates of obesity, cardiovascular disease, and other chronic health problems.[87] The Western diet is described in a variety of ways, but definitions often focus on diets rich in fat, sugar, and salt, with major food sources including pre-packaged foods containing refined grains, sugar, fructose, refined vegetable oils; sugar-sweetened beverages (SSBs); processed or fried meats; and high fat dairy products.[88] This dietary pattern has been exported from urbanized, developed nations to low- and middle-income countries (LMIC).[89] As these LMIC nations have adopted Westernized diets in place of traditional diets, chronic, non-communicable diseases have risen as well. This phenomenon reflects the globalization of processed food consumption. Over time, diets across the world have become less diverse, with LMICs joining high income countries in declining intake of traditional staple foods such as regional vegetables, fruits, grains, and protein sources as intake of animal foods, sweets, fats, and beverages have risen simultaneously.[89]

More recently, UPF has been investigated for concern that the role of additives or processing itself may contribute to non-communicable disease risk as much or more than the fat, sugar, and salt content of these foods. Additionally, the specific combination of fats, sugar, and salt in many UPF may be designed to be hyper-palatable and to drive overconsumption. Many experts agree that diets have become overly reliant on UPF as fewer Americans consume whole foods as a primary component of the diet. In fact, a recent United States Centers for Disease Control and Prevention (CDC) data brief indicated that US adults consume 53% of energy intake from UPF on average, with children 1-18 averaging 62%.[90] This is a major departure in how humans have eaten over the millennia. Despite the general agreement that modern dietary patterns are not healthy, experts continue to debate whether

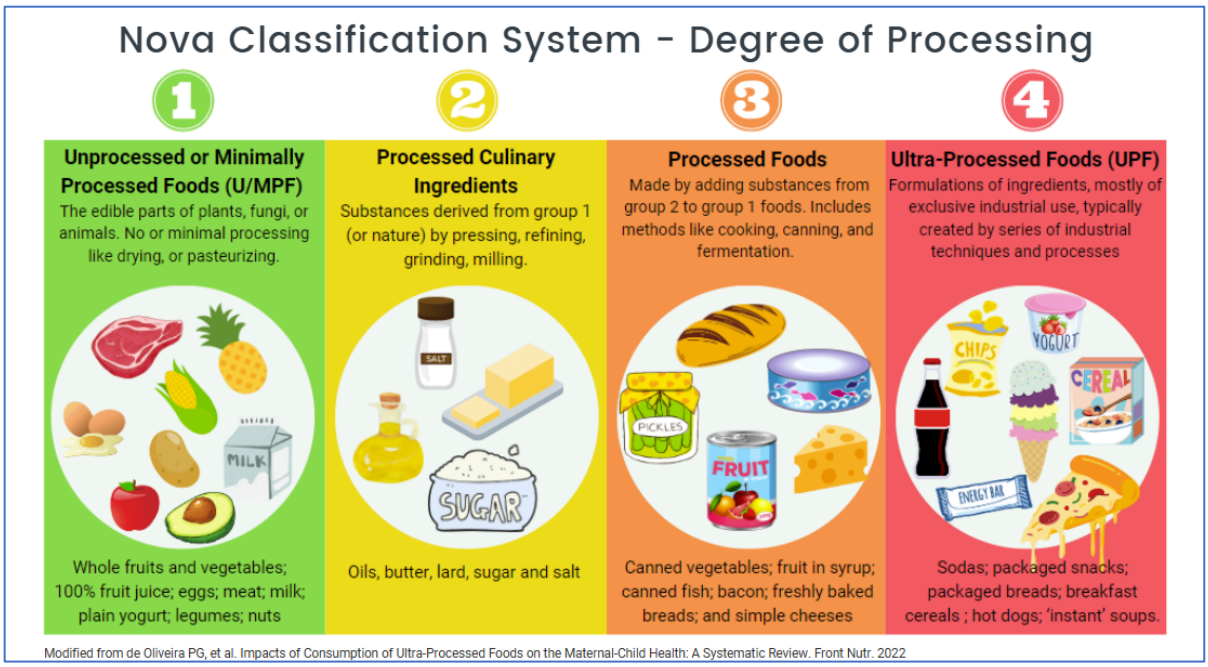
processing itself drives the observed health problems or whether the nutritional quality of processed foods is the major issue.

The first attempt to define UPF came from Mexico.[91] A group of researchers classified foods consumed by one to four-year-olds as processed modern, processed traditional, and non-processed foods to determine what portion of the diet came from processed foods, finding more than 39% of the diets came from processed foods on average.[92] Soon after, researchers in Europe classified the food consumed by Europeans in 10 countries according to processing methods, finding with their classification system that adults consumed 61-79% of energy from highly processed foods.[93] Carlos Monteiro, from Brazil, published a paper asserting that processing itself was a health risk.[94] The classification system he proposed included three groups: one with unprocessed foods together with minimally processed foods; a second group with extracts from these foods plus additives such as sugar, fat, etc.; and finally, ultra-processed food, which are made mostly from ingredients and typically contain no whole foods. Brazil became the first country to regulate advertising of UPF and to issue dietary guidelines suggesting restriction of UPF.[95]

NOVA Classification

Monteiro and colleagues proposed an updated classification system called NOVA as part of a report for the Food and Agriculture Organization of the United Nations (FAO).[96] This system had four groups, which are described below, and argued that processing itself was not so much the issue as the nutritional imbalance caused by consuming too many UPF. Although there is not yet a universally accepted definition of UPF, the UPF definition from the NOVA classification system is the most widely used in research.[97] NOVA classifies all foods and food products, including the individual ingredients of culinary preparations, into four groups based on the nature and purpose of processing: (1) unprocessed or minimally processed foods; (2) processed culinary ingredients; (3) processed foods; and (4) UPF.[98]

Figure 3. NOVA Classification System based on degree of processing, modified from de Oliveira PG, de Sousa JM, Assunção DGF, et al. Impacts of Consumption of Ultra-processed food on the Maternal-Child Health: A Systematic Review. Front Nutr. 2022;9:821657. Published 2022 May 13. doi:10.3389/fnut.2022.821657 by Erin Hudson, JD, PhD. Used with permission.



NOVA group 1, Unprocessed and Minimally Processed Foods, includes foods that are eaten in their natural state or have undergone industrial processes that largely preserve their original food structure (i.e., the matrix).[98] Typical processes include removing inedible parts, cutting, drying, grinding, pasteurization, refrigeration or freezing, non-alcoholic fermentation, and packaging (including vacuum sealing). These processes do not add salt, sugars, oils, fats, or other food substances to the original food. These methods primarily extend shelf life and improve storage, convenience, and versatility for whole foods such as grains and legumes, vegetables and fruits, nuts, milk, meat, poultry, and fish. These foods are often seasoned and cooked with processed culinary ingredients in home or restaurant settings and eaten as part of freshly prepared meals.

NOVA group 2, Processed Culinary Ingredients, includes ingredients either extracted from group 1 foods or obtained from nature such as plant oils, butter, lard, sugar, honey, and salt.[98] They are produced through industrial processes such as pressing, centrifugation, refining, evaporation, extraction, or mining. These ingredients are not typically eaten by themselves. Instead, they are used to prepare group 1 foods.

NOVA group 3, Processed Foods, includes group 1 foods that have been industrially modified by adding salt, sugar, or oils, or other group 2 ingredients, using preparation methods like those used in home kitchens or restaurants.[98] Examples include vegetables in brine, fruits in syrup, canned or cured fish, bakery breads, and cheeses. These foods may be eaten by themselves or as part of freshly prepared meals. Processing in this group is primarily intended to extend shelf life and to modify or enhance sensory characteristics (e.g., taste, texture).

NOVA group 4, Ultra-processed Food (UPF), comprise branded, industrial formulations made primarily from inexpensive substances extracted from foods (e.g., oils, starches, sugars, proteins), derived from food constituents through chemical modification (e.g., hydrogenated fats, modified starches), and/or synthesized in laboratories (e.g., flavorings, colorings, emulsifiers).[98–100]

General Features of Ultra-Processed food

UPF typically contain little to no intact whole food.[98] They are produced through multiple, sequential industrial steps that often begin with fractionating high-yield crops (e.g., corn, wheat, soy, palm) into component ingredients, followed by chemical modifications (e.g., hydrolysis, hydrogenation, interesterification) and industrial assembly techniques (e.g., extrusion, molding, pre-frying). In some products, meat remnants and scraps are also incorporated. Cosmetic additives (including flavors, colors, emulsifiers, and related agents) are used to create or intensify appealing sensory properties, often resulting in hyperpalatable products. UPF are commonly designed to be convenient and shelf-stable, and are marketed in attractive packaging that may include implied or explicit health claims. Conceptually, NOVA identifies UPF based on both the nature and the purpose of processing, including the creation of novel physical and chemical structures to imitate the sensory qualities of freshly prepared foods or to increase palatability.[98,101,102]

A practical way to determine whether a product is a UPF under the NOVA classification is to review the ingredient list for markers of ultra-processing.[99] In general, UPF contain at least one ingredient that is uncommon in home cooking, such as high-fructose corn syrup, hydrogenated or unesterified oils, or hydrolyzed proteins, and/or additives used to engineer sensory qualities and product texture. These additives include flavorings and flavor enhancers (both natural and artificial flavorings), colors, emulsifiers, emulsifying salts, non-sugar sweeteners, thickeners, and other agents added to modify properties such as foaming, gelling, glazing, or bulking.

Critique of the NOVA Classification

The NOVA definition of UPF is often criticized as too broad because it can place foods with drastically different nutritional profiles and plausible health implications into the same “ultra-processed” category (e.g. Coca-Cola vs. flavored sparkling water). Since NOVA is defined by the nature and purpose of industrial processing rather than nutrient composition, some products that many consumers perceive as relatively healthful can still meet the UPF definition, such as flavored yogurts, whole wheat sandwich bread, and certain commercially available tofu products. It also includes all meat-substitute products and many plant-based dairy analogs. This raises concern that

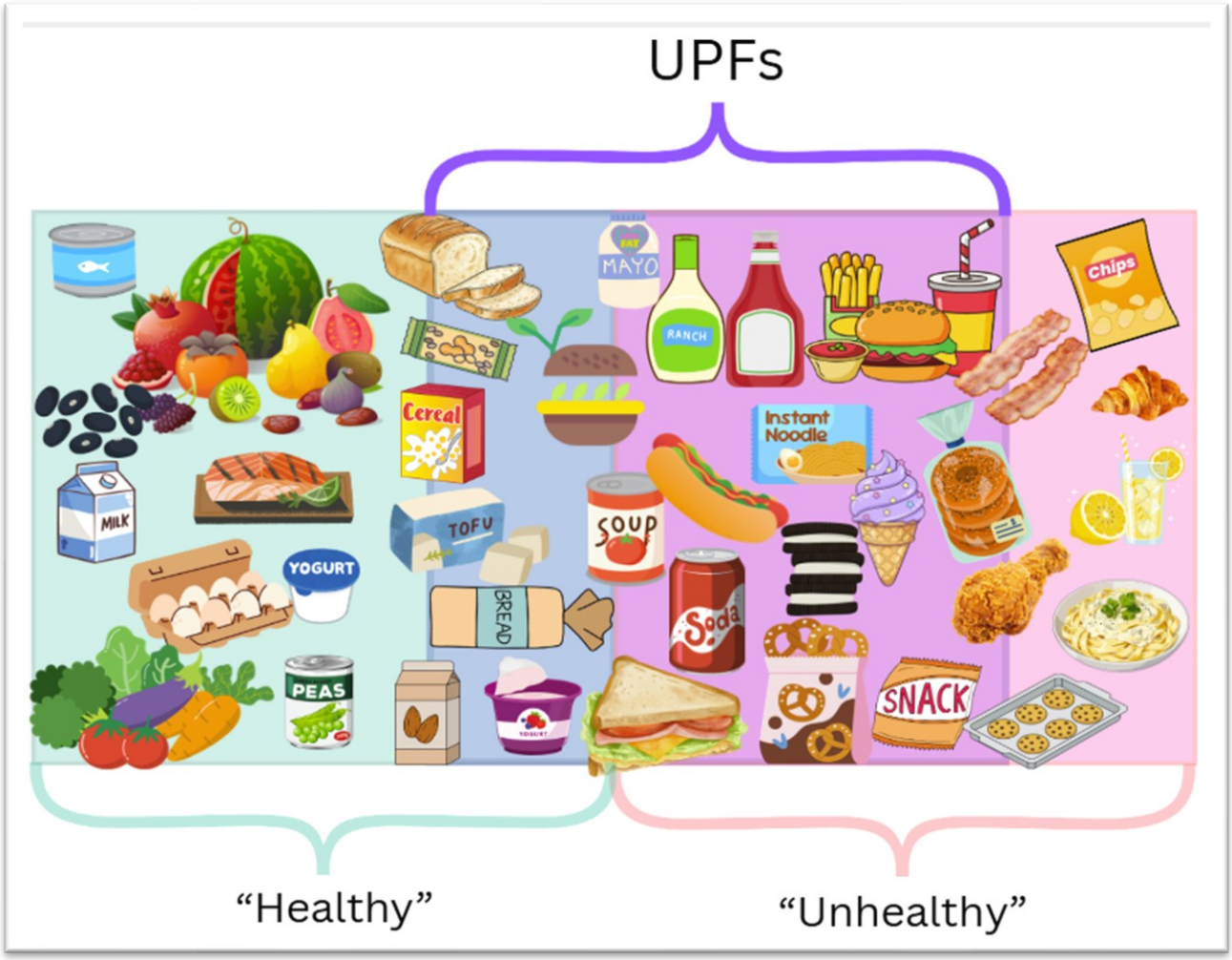
NOVA may "over-classify" foods as ultra-processed by grouping these items alongside products more consistently viewed as harmful, such as sodas, packaged desserts, and highly processed, ready-to-eat meals. As noted in the recent report for the Scientific Foundation for the Dietary Guidelines, this breadth would be expected to dilute observed associations of UPF with chronic disease because including less harmful items in the UPF category would decrease the overall effect.[103] As such, consistent adverse associations of UPF (defined using the NOVA system) with various adverse health outcomes suggests that risks of UPF might be even greater than what is demonstrated in current literature if foods with relatively healthy nutrient profiles were excluded from the group.

A related criticism is that the NOVA definition of UPF does not include all foods commonly labeled "junk food." Some highly energy-dense, nutrient-poor foods can be made with a short list of familiar culinary ingredients and may fall outside the NOVA UPF definition. For example, products might be made with "clean labels" containing only basic ingredients (potato chips made with potatoes, oil, salt), placing them in NOVA group 3, together with foods such as candy made with "clean labels." Similarly, baked goods made at home or in a bakery are not considered UPF, nor are most homemade pasta dishes or fried chicken. These foods likely have unfavorable nutrient profiles.

To give these criticisms some context, the term "NOVA" comes from the Portuguese word for "new," reflecting the system's origins in Brazil and its focus on a new classification system to capture newer forms of industrial food processing. It is not intended to replace well-established nutrition principles. The NOVA UPF classification cannot function as a standalone proxy for "unhealthy eating" and needs to be considered alongside well-established nutrition principles (e.g., sugar or energy-density). Figure 2 illustrates the overlap and intersection of these concepts.

Similarly, there are ultra-processed medical foods that have been shown to mitigate risk of disease, such as the use of industrially created tube feeding formulas to improve disease remission in Crohn's disease, use of medical foods for people with phenylketonuria (PKU), and use of infant formulas for infants with severe allergies. These are just a few examples, but they illustrate that UPF are not all the same and do not necessarily present the same risk, regardless of definitions. However, we will endeavor to present the overall risk of increased UPF consumption, especially as it displaces unprocessed and minimally processed foods in the diet, laying out where the scientific literature overall indicates greatly increased risk, somewhat increased risk, no increased risk, or unclear findings needing more research.

Figure 4. Conceptual illustration showing that UPF spans a spectrum of nutritional quality. Whole and minimally processed foods are shown on the left ("healthy"), while more energy-dense, less nutritious foods are shown on the right ("unhealthy"). The bracket labeled "UPFs" spans foods across both sides to illustrate that not all UPF have the same nutritional profile. Designed by Erin Hudson, JD, PhD. Used with permission.



Developing Regulatory Definitions of UPF

In recent years, state governments, beginning with Arizona but including 17 states, have codified a definition of UPF that will enable regulation of it in various contexts (most often school lunches).[104] Most of these regulations operationalize the definition by identifying ingredient categories that are markers of ultra-processing.[105,106] Some also incorporate traditional measures of diet quality, such as amount of fat, sugar, or sodium.[107] While these efforts reflect growing concern regarding the potential health impacts of UPF, inconsistencies across state definitions may create challenges for school food policies and procurement, SNAP (Supplemental Nutrition Assistance

Program), WIC (Women, Infants, and Children) food packages, and other settings where food procurement is needed.

There is currently a joint effort by the USDA and FDA to establish a uniform definition of UPF for federal regulation, which will in turn guide researchers. As part of this effort, the FDA and USDA issued a request for information last year and received over 5,000 comments. Because no federal definition has yet been established, the recently issued DGA avoided the term entirely, instead recommending that Americans limit "highly processed foods." Similar to the NOVA UPF definition, highly processed foods were defined as "any food, beverage, or engineered food-like item that is made primarily from substances extracted from foods (such as refined sugars, refined grains/starches, and refined oils) and/or containing industrially manufactured chemical additives."[97]

Recent efforts to define UPF have highlighted both the growing scientific consensus regarding potential health concerns and the ongoing challenges of developing definitions that can be applied consistently across research, public health practice, and policy settings. In 2026, an expert panel convened by Healthy Eating Research (HER) released recommendations for a U.S.-specific UPF definition designed to improve consistency across studies and applications.[108] The panel emphasized that existing classification systems, including NOVA, have advanced the field but can be difficult to operationalize because products with similar nutrient profiles may be classified differently based on processing methods or ingredients. The HER recommendations therefore seek to create a transparent and reproducible framework that can be used across research, surveillance, and food programs while remaining adaptable as the evidence base evolves.

The HER panel recommends the following definition[109]:

1. A food product is ultra-processed if it contains at least one UPF marker ingredient:

    A. **Cosmetic additive.**
    Examples: flavors (natural or artificial), sweeteners (non-sugar sweeteners), emulsifiers, colors (natural or artificial), and thickeners and/or

    B. **Ingredient of non-culinary use.**
    Examples: industrial ingredients not typically found in home kitchens, like high fructose corn syrup.

1. Foods that meet FDA's definition for "Healthy" would be exempt from UPF policies. FDA healthy foods contain: 1) adequate amounts of recommended food groups; and 2) Amount of added sugar, sodium, and saturated fat less than FDA-recommended levels.

The panel recommends that products containing non-sugar sweeteners would not qualify for this exemption.

The release of these recommendations coincides with a growing body of U.S.-focused scholarship examining the health implications of UPF and the methodological challenges involved in studying them. A special issue of the American Journal of Public Health published in June of 2026 highlighted emerging evidence linking higher UPF consumption with poorer dietary quality and adverse health outcomes while also emphasizing the need for clearer definitions, improved measurement approaches, and greater attention to the complex relationships among food processing, nutrient composition, food environments, and healthy food access for all.[110] Collectively, this work suggests that advancing the science of UPF will require continued efforts to distinguish the effects of food processing itself from other characteristics of foods and dietary patterns, while providing consumers, researchers, and practitioners with practical and understandable ways to identify and study foods of concern.

In summary, how to correctly classify and define UPF remains under development. In the absence of agreed-on definitions or an FDA adopted definition, the NOVA system remains the most widely used. In fact, the United States Department of Agriculture's Food and Nutrient Database for Dietary Studies (FNDDS) and the National Cancer Institute's Automated Self-Administered Dietary Recall system (ASA-24) recently were integrated with NOVA classifications.[111] This makes it possible for researchers to more easily assess UPF intake when assessing self-reported dietary intake, in addition to traditional nutrient data such as kilocalories, protein, fat, added sugar, micronutrients, etc. Because the NOVA UPF definition is in wide use, including by U.S. agencies and state legislation, we will adopt the same definition when assessing the risk of UPF in the scientific literature for this report.

Given its widespread use in scientific literature, integration into federal dietary assessment tools, and adoption in emerging policy frameworks, the NOVA classification provides a practical and evidence-informed foundation for evaluating UPF consumption when paired with traditional nutrition principles.[78] While not without limitations, it offers a necessary starting point for advancing research, informing policy, and guiding public health recommendations aimed at reducing chronic disease risk.

How UPF & Processing May Drive Disease Risk

Potential Mechanisms of UPF Risk

There are several hypotheses regarding the relationship between UPF and higher risk of chronic diseases. As described in a recent article by Monteiro et al., the first

hypothesis is that UPF displaces whole foods in the diet, thus reducing intake of nutrients and bioactive compounds present in whole foods such as fiber and phytochemicals.[98] The second hypothesis focuses on how intake of UPF contributes to lower dietary quality, driven by overeating highly palatable, soft foods with specially created food matrices, together with lower intake of bioactive compounds and increased intake of "toxic compounds, endocrine disruptors, and potentially harmful classes and mixtures of food additives."[98] The third hypothesis is that UPF is independently a key driver of chronic disease.

Nutrient Displacement and Dietary Quality

How UPF may contribute to risk of chronic disease continues to be debated. UPF may contribute to lower dietary quality through displacement of whole foods in the diet, with several studies reporting high UPF intake to correlate with low dietary quality.[112–119] However, UPF intake has also been linked with cardiometabolic disease risk independent of diet quality, suggesting other mechanisms may be involved.[120–124] For example, in a study of over 22,000 adults in Italy, those with the highest UPF intake had a 58% higher risk of mortality from cardiovascular disease compared to those with the lowest intake, and less than half of this effect was explained by sugar and cholesterol content.[120] The magnitude of the association between UPF consumption and mortality was greater among participants with higher diet quality measured by adherence to the Mediterranean diet than those with lower adherence.[125]

UPF and Gut Microbiota

One factor which could account for the finding of an independent effect of processing beyond dietary quality or displacement could be the impact of specific ingredients within UPF on gut microbiota composition and function.[126] For example, non-nutritive sweeteners (NNSs), which are common in UPF, have been linked to impaired glycemic responses. Clinical trials suggest that human NNS consumption leads to microbiome-dependent glycemic alterations.[127,128] While NNSs offer certain benefits, including reduced caloric intake and improved blood sugar regulation, their impact on gut microbiome health raises concerns. Importantly, our gut microbiome is a key regulator of gut barrier function, inflammation, and metabolism. Thus, having increased intake of UPF ingredients could reduce the diversity of the gut microbiome, as well as alter the composition and function that could lead to increased gut permeability and inflammation.[126]

Emulsifiers are among the most ubiquitous additives in UPF.[129] In animal models, isolated emulsifiers such as polysorbate 80 and carboxymethylcellulose have altered gut microbiota composition and promoted metabolic syndrome,[126] and a human RCT

confirmed that carboxymethylcellulose alone produces detrimental shifts in the gut microbiome and metabolome.[130] Observational data extend these findings to habitual dietary patterns.[131] In a large prospective cohort, several commonly used emulsifiers were each associated with higher T2DM incidence in dose-response analyses,[132] and risk of CVD.[133]

A critical function of the gut microbiota is to ferment dietary fiber and produce beneficial metabolites such as short-chain fatty acids (SCFA). Our body relies on beneficial gut microbiota to balance both immune and metabolic homeostasis.[134] UPF-related reduction in beneficial gut bacteria could disrupt SCFA production that would impact gut health generally, as well as contribute to increased inflammation, and could influence other aspects of our metabolism.

Industrial Processing Byproducts

Other research focuses on the impact of industrial processing on promoting the production of compounds such as acrylamide and advanced glycation end-products (AGEs) that foster oxidative stress and vascular damage.[135,136] It should be noted that acrylamide and AGEs are also produced through traditional cooking methods such as baking, grilling, and frying, and occur in homemade, fresh foods. However, it is possible that dietary patterns based on UPF are higher than average in these compounds.

Food Matrix and Satiety Disruption

Another potential mechanism for UPF to influence health is through the loss of a firm food matrix. The use of soft, rapidly digestible textures may blunt normal satiety signaling and metabolic hormone release, promoting overeating.[137–139] In addition, many UPF are hyperpalatable and energy dense, which could also lead to excess intake of foods that are also high in energy, fat, sugar, and salt.[140–143]

Figure 5A. Potential mechanisms linking UPF to adverse health outcomes.[90,99,142,144–148] Foods defined per NOVA; pathways vary in evidence strength. Abbreviation key follows.

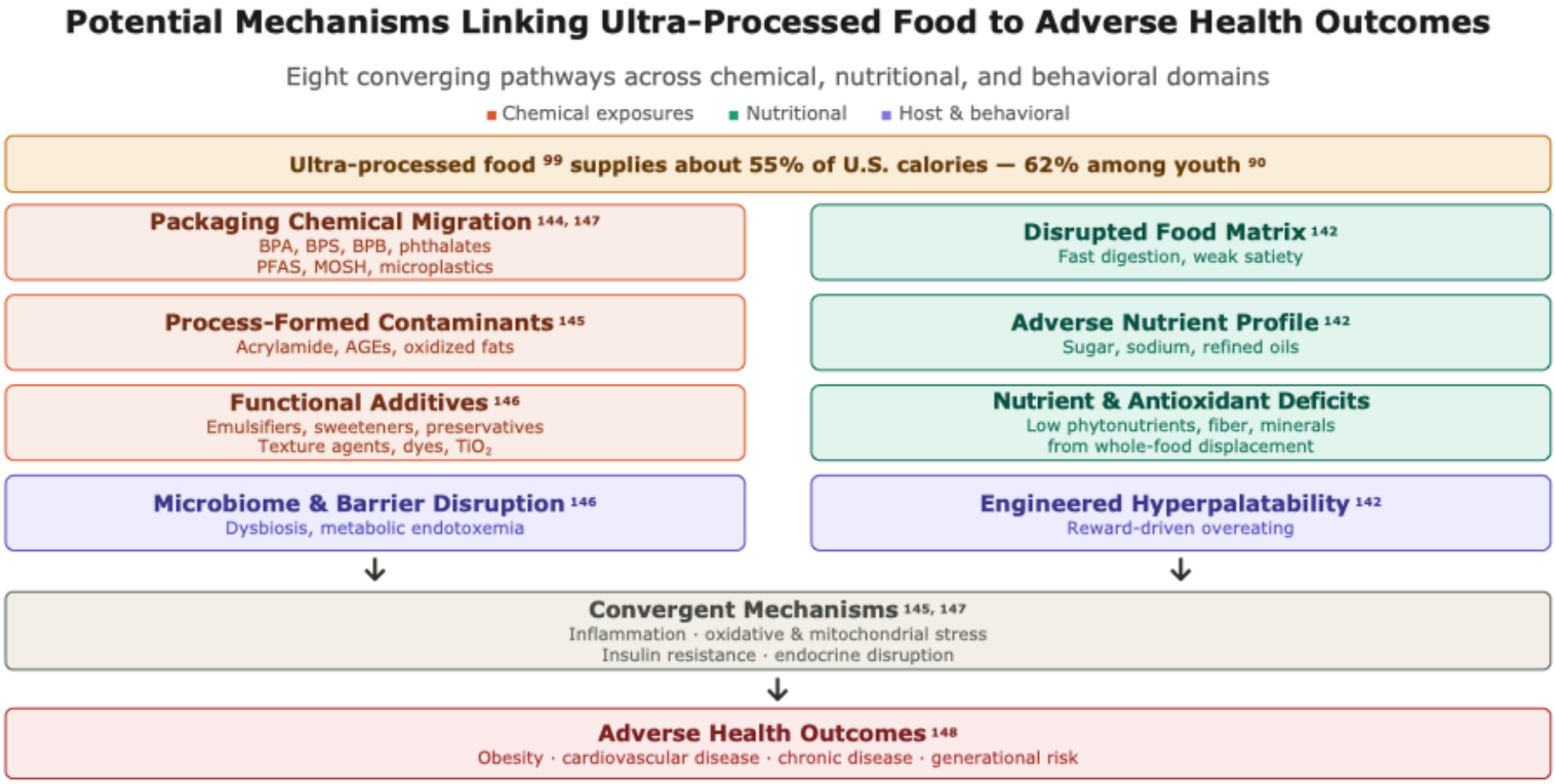


Figure 5B: Key for Abbreviations and Acronyms in Figure 5A.

Abbreviation	Term
AGEs	Advanced glycation end-products
BPA	Bisphenol A
BPB	Bisphenol B
BPS	Bisphenol S
MOSH	Mineral oil saturated hydrocarbons
PFAS	Per- and poly-fluoroalkyl substances
TiO_2	Titanium-dioxide

Categories of Health Consequences & Evidence Summaries

The following scientific review chapters were developed through a structured evidence review process, including collaboration with SMEs across relevant fields, as previously described in this report. The TNAC defined eight core topic areas as well as common examples of disease states and provided these as well as a broadly defined search strategy to DSHS librarians (available in the **Search and Literature Review Strategy** (**Supplement 2**) of the Additional Supplementary Resources). The librarians then applied a basic search approach to pull articles that would support answering two key questions for each topic area. Due to the inability to define a highly detailed and completely thorough search strategy with the limited report timeline, reviewers and SMEs were given permission to add essential articles they determined to be missing from the basic search and to similarly eliminate articles that were not relevant to the key questions, clearly noting to which articles this approach applied.

Key Questions

Question A (Qa): What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of the disease or health outcome specific to each group's focus across all life stages?

Question B (Qb): What is the relationship between nutrient-dense diets or high dietary quality diets and the outcome of the sub-group's interest (regardless of level of processing) across all life stages?

Topic areas included:

Metabolic Health (e.g., cardiovascular disease, chronic kidney disease, diabetes, obesity)

Cancer (e.g., prevention, treatment, secondary prevention of all types)

Gastrointestinal Health (e.g., inflammatory and irritable bowel diseases)

Mental Health (e.g., anxiety, depression, attention deficit hyperactivity disorder)

Immune System Health (e.g., inflammation, allergy, autoimmune conditions)

Brain Health (e.g., dementia, Parkinson's disease, cognitive function)

Reproductive Health (e.g., female and male infertility, endometriosis, polycystic ovary syndrome, menstrual irregularities, pregnancy outcomes)

All-Cause and Cause-Specific Mortality

These chapters are included within the main report to preserve the scientific context, nuance, and rigor necessary for thoughtful interpretation of the complex and evolving nutrition science literature. Detailed evidence summary tables supporting each chapter are available in **Supplement 2** of the Additional Supplementary Resources, and contributors for each section are outlined in the **Contributors Appendix B**.

To enhance accessibility for broader audiences, key findings and practical takeaways from each chapter are also summarized in lay-friendly language within the Executive Summary.

Metabolic Health and Dietary Pattern

Methods

Source of Evidence

The SME team was charged with answering the two questions outlined in the introduction with respect to metabolic health and was provided two .txt file documents containing the abstracts of 75 studies that DSHS identified through a literature search: one file titled "UPF Metabolic Health" that included abstracts from 43 studies and

another file titled "Minimally Processed Metabolic Health" that included abstracts from 32 studies. The SMEs were not aware of the full DSHS library search strategy (including databases searched besides PubMed, complete search terms, or screening criteria), so the SME teams could not independently replicate the search. The SME team identified more than 30 additional relevant studies in addition to the DSHS-provided studies that the SMEs were familiar with from their own research. The 13 most consequential were added, resulting in 88 studies for the SME team to review.

Findings: UPF and Metabolic Health

The evidence links dietary patterns high in UPF with higher BMI, higher risk of Type 2 Diabetes Mellitus (T2DM), more cardiovascular events and CV mortality, and greater risk of liver disease. Evidence on intermediate biomarkers for glycemia and cardiovascular disease is more limited. The below summary of evidence discusses select, illustrative studies and does not include all studies that were considered in grading the evidence for each cluster. Those details are available in the **Evidence Review and Grading Tables** (**Supplement 2**) of the Additional Supplementary Resources.

Table 1. Evidence Gradings for Relationship between UPF and Metabolic Outcomes from SME Team. Note that children are included in some, but not all studies, and pediatric-specific evidence is summarized at the end of this section (but not yet sufficient for independent grading on each metabolic outcome).

Metabolic Outcome	Grade	Rationale
Body Weight and Adiposity	**I**	Four controlled feeding trials favoring minimal processing; large cohorts replicate across the life span.
T2DM	**I**	Two meta-analyses (n=900,000+); multiple systematic reviews; plus six large cohorts; consistent dose-response.
Glycemia (e.g., FG, HbA1c, Insulin, HOMA-IR)	**III**	Small body of evidence provided, mostly secondary outcomes, mixed findings.
Cardiovascular Events (e.g., HTN, CV events, CV mortality, VTE)	**II**	Multiple large cohorts agree on direction; however multiple outcomes reduce quantity of evidence for any single outcome.
Cardiovascular Biomarkers (e.g., lipids, blood pressure)	**III**	Mixed, largely null findings; four feeding trials not powered for these outcomes; few studies in reviewed literature with this outcome
Liver Disease (MASLD, fibrosis, cirrhosis)	**III**	Two recent meta-analyses (>1M participants) + UK Biobank cohorts; consistent dose-response; but strength/quality of evidence is generally weak

Body Weight and Adiposity - Grade I (Good/Strong)

Conclusion: Dietary patterns high in UPF are consistently associated with greater body weight, adiposity measures, and incident obesity.

Grade: I (Good/Strong)

UPF intake is consistently linked to greater body weight, obesity, and adiposity. This link is supported by each of the four randomized controlled feeding trials to date that have compared a primarily UPF diet to a minimally processed diet. Hall et al. is the seminal controlled study in this field.[142] Twenty weight-stable adults were confined to a metabolic ward at the NIH Clinical Center and randomized to consume either a UPF or a minimally processed diet ad libitum for two weeks before crossing over to the alternate diet. Both diets were matched for calories, macronutrient composition, sugar, sodium, and fiber. Participants ate approximately 500 kcal per day more on the UPF diet and gained 0.9 kg. The participants lost a comparable amount of weight on the minimally processed diet. Hamano et al. replicated this design in nine men with overweight or obesity in Japan.[149] During Hamano's one-week UPF arm, participants consumed 814 kcal more per day and gained 1.1 kg compared with the minimally processed arm. In another crossover feeding trial, Dicken et al. extended the work into a free-living trial of 50 UK adults randomized to consume UPF and minimally processed diets that both complied with national dietary guidelines for eight weeks each.[150] Both diets produced weight loss, but on the minimally processed diet, participants experienced 1.4 kg more weight loss and consumed 327 fewer kcal per day than the UPF diet. Preston et al. addressed whether UPF would still produce weight gain when energy intake was held constant.[151] In a fixed-calorie crossover of 43 Danish men, participants gained more weight on the UPF arm in both the adequate-calorie arm (+1.4 kg) and the excess-calorie arm (+1.3 kg), with fat mass also increasing by about 1 kg on the UPF diet in both conditions. Relatedly, a study found that replacing UPF with NOVA 1 and NOVA 2 food was associated with reductions in body weight and percentage body fat.[152] Collectively, these trials provide consistent causal evidence that UPF diets promote weight gain compared with minimally processed diets, and Preston's fixed-calorie design suggests the effect persists even when calories are fixed. The observational literature aligns with the trials and is reflected in recent reviews and meta-analyses. Multiple prospective cohorts report associations between higher UPF intake and weight, adiposity measures, or obesity in adults.[148,153,154]

In pediatric populations, there has not yet been a randomized controlled trial similar to those conducted in adults. However, a 2022 study randomized 60 children in China to a government-recommended diet or a minimally processed diet and found both diets reduced body weight and adiposity markers, with a greater reduction in adiposity in

the minimally processed diet.[155] With few exceptions (with null results), UPF intake is consistently positively associated with BMI and adiposity with children.[156–160]

We graded this body of evidence I (Good/Strong). The DGA Foundation Report graded body weight and adiposity Moderate.[161] The Lane BMJ umbrella graded it Class II/III, and the Dai Clinical Nutrition umbrella graded it Class II.[148,154] We grade one step higher because the post-DGA controlled-feeding trials[149–151] add directly meaningful evidence that the DGA Scientific Report did not have at finalization.

Type 2 Diabetes - Grade I (Good/Strong)

Conclusion: Dietary patterns high in UPF are consistently linked to a higher risk of developing T2DM in adults.

Grade: I (Good/Strong)

In recent meta-analyses, the association between UPF and incident T2DM is the most consistent positive association identified.[148,154] Lane et al. classified the T2DM finding as Class I (convincing), the highest tier in its grading framework.[148] The most recent dose-response meta-analysis of 12 prospective cohorts estimated a 48% higher T2DM risk for the highest versus lowest UPF intake, with associations persisting after adjustment for diet quality, energy intake, and BMI.[162]

Individual cohorts add context to the pooled estimates. In a U.S. cohort (ARIC, n=13,172), the highest quartile of UPF intake was associated with 13% higher T2DM risk over 21 years of follow-up.[163] Another study pooled three large U.S. cohorts and reached a similar conclusion.[164] Other large prospective cohorts confirm the direction in non-U.S. populations.[165,166] Two studies published earlier this year add to the evidence base. Hasenböhler et al. linked preservative food additives (common in UPF) to T2DM incidence in a French population,[167] and a study in Brazil found that minimally processed diets are protective against developing T2DM.[168]

The SME team grades this body of evidence I (Good/Strong). The DGA Foundation Report graded T2DM high.[161] The Lane BMJ umbrella graded it Class I (convincing).[148] The Dai Clinical Nutrition umbrella graded it Class II (highly suggestive).[154] Large prospective cohorts with rigorous exposure assessment plus dose-response meta-analytic confirmation constitute strong design for this question.

Among adults who already have T2DM, the association between UPF intake and diabetes management or progression is less robust but directionally consistent with the incident disease literature. In the Italian Moli-sani cohort, among adults with T2DM, higher UPF intake was associated with higher cardiovascular and all-cause mortality

independent of overall diet quality.[121] In the UK Biobank, higher UPF intake among adults with T2DM was associated with greater risk of microvascular complications.[169] Because there were only two studies evaluating the implications of ultra-processed dietary patterns for people with T2DM, the SME team did not grade this evidence.

Glycemia (Fasting Glucose, HbA1c, Insulin, HOMA-IR) - Grade III (Limited/Weak)

Conclusion: Evidence on UPF intake and glycemic markers, separate from the incident T2DM evidence above, is limited and inconsistent.

Grade: III (Limited/Weak)

No randomized trial has been designed with glucose dynamics (e.g., HbA1c, HOMA-IR, continuous glucose outcomes) as a primary outcome. The four controlled-feeding randomized trials that tested UPF diets versus minimally processed diets measured glycemic markers as secondary outcomes, and the findings are mixed.

Hall et al. reported that HOMA-IR decreased on the minimally processed diet relative to baseline but did not differ between the UPF and minimally processed arms.[142] Mean glucose trended higher on the UPF diet without reaching significance. The authors speculated that participants' habitual diets were likely high in UPF and that the daily exercise protocol may have attenuated glycemic differences.[142] Hamano et al. reported significantly higher fasting glucose at the end of the UPF arm but no between-diet differences in HbA1c.[149] Dicken et al. found HbA1c was lower at eight weeks compared with baseline on the minimally processed arm, and fasting glucose was lower at eight weeks compared with baseline on the UPF arm, but neither marker differed significantly between diets.[150] Preston et al. reported no significant between-diet differences in fasting glucose or HbA1c.[151]

Other experimental studies have also considered glycemic biomarkers as secondary outcomes. Vaezi et al. enrolled U.S. older adults with a habitual high-UPF diet (~50% of energy) and placed them on a minimally processed diet (~13% of energy) for 8 weeks and reported approximately 24% improvement in HOMA-IR.[170] Participants also lost 3.8 to 4.4 kg over the same period, making it difficult to attribute the insulin sensitivity improvement to UPF reduction rather than to meaningful weight loss. In a secondary analysis of a controlled feeding trial Ginos et al. observed a modest increase in circulating bile acids beneficial to glucose homeostasis following a "whole grain diet" (whole grains, legumes, and fruits and vegetables) compared to a refined grain diet (high in refined grains and added sugars).[171] Notably, the intervention diets were designed to differ in carbohydrate source/glycemic load, rather than a direct comparison of minimally processed foods vs. UPF.

A separate food-level analysis is consistent with the cohort and trial findings. In this analysis, 98 commercially available ready-to-eat foods were classified using NOVA and matched to published glycemic index values.[137] Across these 98 foods, minimally processed items were less hyperglycemic than ultra-processed items. This food-level analysis is conceptual and does not measure what happens to blood glucose when a person consumes a habitual UPF-heavy diet over time, thus it contributes little to the evidence grading.

Pediatric observational evidence is small and inconsistent. In the U.S. CORALS prospective cohort of approximately 2,638 children ages six to twelve, higher UPF intake was associated with higher fasting plasma glucose, with significant differences across UPF quintiles.[159] Two Latin American pediatric cohorts reported mixed results in children and adolescents. In children, UPF was linked to adiposity but not any glycemic markers.[172] However, in Brazilian adolescents, UPF intake and fasting insulin and HOMA-IR were positively associated.[173] In all three studies, glycemic markers were secondary outcomes and effect sizes were small.

The SME team graded this body of evidence III (Limited/Weak). Neither the DGA Foundation Report nor the Lane umbrella separately graded glycemia.[148,161] The Dai umbrella review included glycemic outcomes within broader gradings.[154] The clinical outcome (incident T2DM) is separately supported at Grade I, and the intermediate-marker evidence does not change that conclusion.

Cardiovascular Events (Hypertension, CV Events, CV Mortality, VTE) - Grade II (Fair)

Conclusion: Dietary patterns high in UPF are linked to incident cardiovascular events and cardiovascular mortality in adults.

Grade: II (Fair)

In the U.S. ARIC cohort, the highest quartile of UPF intake was associated with 15% higher risk of incident hypertension over 30 years of follow-up.[174] There was a similar positive association between UPF intake and incident hypertension from a cohort in Iran.[175] In UK Biobank, higher UPF intake was associated with elevated risk of venous thromboembolism among 186,323 adults.[176] The Moli-sani cohort in Italy reported that among participants with T2DM, the highest UPF consumers had higher cardiovascular mortality independent of overall diet quality.[121] This finding was recently replicated in the Melbourne Collaborative Cohort Study.[177]

The SME team grades this body of evidence II (Fair). The evidence of the link between UPF intake and CV events is weaker than the link between UPF and body

weight/adiposity or incident T2DM. The evidence in this review rests on large prospective cohorts across the U.S., Europe, the Middle East, and Australia, with multiple outcomes limiting the quantity of evidence available to support any specific outcome. This grade is consistent with the DGA Foundation Report, which graded cardiovascular outcomes Moderate.[161] The Lane and Dai umbrellas both graded it Class III.[148,154]

Cardiovascular Biomarkers (Dyslipidemia, Lipid Profile, Blood Pressure Changes) - Grade III (Limited/Weak)

Conclusion: Evidence on UPF intake and cardiovascular biomarkers (lipid panels and blood pressure) is limited and inconsistent.

Grade: III (Limited/Weak)

The four controlled-feeding randomized trials of UPF diets versus minimally processed diets each reported lipid outcomes as secondary outcomes, but none was powered for these outcomes, and the findings are mixed. Hamano et al. and Dicken et al. reported significant between-diet differences favoring the minimally processed diet.[149,150] Hall et al. and Preston et al. did not.[142,151] Cholesterol findings were similarly mixed. Total cholesterol decreased on the minimally processed diet relative to baseline in three of the four trials, with only Hamano et al. reporting a significant between-diet difference.[142,149–151] Preston et al. found significantly higher total cholesterol and a higher LDL:HDL ratio on the UPF-adequate-calorie condition, though not in the excess-calorie condition.[151] LDL-C was paradoxically lower on the UPF arm in Dicken et al., which the authors attributed to the nutritionally reformulated UPF products used in that trial.[150] HDL decreased relative to baseline in all three *ad libitum* trials regardless of diet.[142,149,150]

In a behavioral intervention, older U.S. adults who shifted from a habitual high-UPF diet (~50% of energy) to either of two minimally processed diets (UPF ~13% of energy) for eight weeks showed improvements in both triglycerides and total cholesterol.[170] As with the glycemic findings above, participants also lost 3.8 to 4.4 kg over the same period, complicating attribution of the lipid changes to UPF reduction rather than to weight loss. In a study pooling three Korean cohorts, there were no associations between UPF intake and dyslipidemia.[178]

We grade this body of evidence III (Limited/Weak). The body of evidence reporting cardiovascular biomarkers in this review is small, mostly secondary outcome analyses, and inconsistent in direction. Neither the DGA Foundation Report nor the Lane 2024 BMJ umbrella separately graded UPF and lipid or blood pressure outcomes.[148,161] The Dai 2024 umbrella graded dyslipidemia at Class III to IV.[154]

Liver Disease (MASLD, Fibrosis, Cirrhosis) - Grade II (Fair)

Conclusion: Dietary patterns high in UPF are frequently associated with Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD, formerly known as NAFLD), hepatic fibrosis, and severe liver disease in adults.

Grade: II (Fair)

Two recent meta-analyses pooling over a million participants support the association. In a dose-response meta-analysis of 17 studies, UPF intake increased the risk of MASLD, liver fibrosis, and liver cancer.[179] In another meta-analysis earlier this year, that included seven studies, there was a pooled hazard ratio (HR) of 1.32 for MASLD at the highest UPF intake but no association for liver cancer.[180]

The cohort evidence comes from two large UK Biobank analyses, which reported positive dose-response associations between UPF intake and MASLD, liver fibrosis/cirrhosis, severe liver disease, and hospitalization or death from liver disease.[181,182] Similarly, in an Iranian cohort, participants in the highest quartile of UPF consumption had more than twice the odds of MASLD compared with the lowest.[183] The body of evidence lacks geographic diversity. The meta-analyses pool a broader set of cohorts but draw heavily on these three cohorts. This review did not include any pediatric evidence.

We grade this body of evidence III (Limited/Weak). This is consistent with prior reviews. The DGA Foundation Report graded MASLD Low.[161] Lane et al. graded liver outcomes Class IV, and Dai et al. did not separately assess them.[148,154]

Pediatric-Specific Evidence

The associations between UPF intake and cardiometabolic risk seem to emerge early in life. Several pediatric cohorts report associations between higher UPF intake and adverse metabolic indicators starting in preschool. Pediatric evidence broadly is concentrated in body weight and adiposity, with limited research on cardiovascular biomarkers and glycemia, and a dearth of pediatric evidence on incident T2DM or liver disease in the included studies.

Body weight and adiposity. The strongest pediatric evidence is for the association between ultra-processed dietary patterns and body weight or adiposity. Cohorts in the included studies span preschool through adolescence and consistently report associations between higher UPF intake and higher BMI or adiposity. In U.S. preschoolers ages three to five, two studies reported that higher UPF consumption at baseline was associated with higher BMI z-score over follow-up.[158,184] In Spanish

preschoolers ages three to six, children in the highest tertile of UPF intake had higher BMI z-score and higher waist circumference compared with the lowest.[159] A substitution analysis from a Canadian cohort showed that replacing 100 g of UPF with 100 g of unprocessed or minimally processed foods was associated with lower BMI and fat mass z-scores.[185] In young Chilean children, higher UPF intake at age four was associated with higher UPF intake and higher BMI z-score, waist circumference, and fat mass at age six.[172]

In older children, the Growing Up Today Study followed U.S. children and adolescents ages seven to 17 and reported associations between higher UPF intake and BMI gain over time.[157] Similarly, a cohort of Canadian children reported positive associations between UPF intake and obesity development.[156] This association between UPF and weight gain or obesity has been replicated in cohorts in many other countries including Spain, Portugal, and Chile.[159,160,172] A 2023 systematic review of nine pediatric cohort studies of UPF and metabolic syndrome components similarly found that the majority of cohorts showed at least one significant association between UPF intake and weight/adiposity measures (e.g., BMI, waist circumference).[173]

Cardiovascular biomarkers and blood pressure. The link between UPF intake and cardiovascular markers may also begin in early childhood. In a Dutch intervention to increase minimally and unprocessed foods in preschoolers ages three to five, the children in the intervention experienced improved HDL level compared to control.[186] In a Spanish cohort of children aged three to six years old, the highest tertile of UPF intake was associated with lower HDL cholesterol z-score.[159] However, in a cohort that followed European adolescents into adulthood, UPF intake was again associated with lower non-HDL cholesterol.[187] One study in this review followed children from age three to age eight and reported higher diastolic blood pressure at age eight in children with higher UPF exposure.[185]

Glycemia. Pediatric glycemic evidence in the studies reviewed is limited to three observational studies. A 2023 systematic review pooled nine cohort studies of UPF and metabolic syndrome components in children and adolescents and reported that seven of the nine cohorts showed at least one significant association between UPF intake and a component of metabolic syndrome.[173] In the Spanish preschool cohort discussed above, higher UPF tertile was associated with higher fasting plasma glucose z-score, and a substitution analysis showed that replacing UPF with unprocessed or minimally processed foods was associated with lower fasting plasma glucose, though HOMA-IR was not significantly associated with UPF intake.[159] In contrast to these findings, a prospective cohort of 962 Chilean preschoolers measured UPF intake at age four and metabolic indicators at age six and reported associations with adiposity but no significant associations with fasting glucose, insulin, or HOMA-IR.[172]

These pediatric-specific findings do not change the overall evidence grading. However, they demonstrate that the concerning link between UPF intake and certain metabolic outcomes may begin at an early age. Notably, most pediatric cohorts in this review were Brazilian, European, or Canadian, where average UPF intake is lower than in the U.S. More U.S.-specific pediatric cohorts measuring UPF intake and metabolic outcomes are needed.

Findings: Diet Quality and Metabolic Health (Q2)

Among all 16 studies reviewed as relevant to Qb, higher-quality dietary patterns were consistently associated with better metabolic outcomes, regardless of how diet quality was defined. The studies used a wide range of dietary frameworks including established named patterns (Mediterranean, DASH, plant-based), national dietary guideline-based scores (such as PNNS-GS in France and DQS in Denmark), food-quality scoring (Nutri-Score), and food-group analyses (fruit and vegetable intake; whole grains). The direction of findings was the same across these frameworks: higher diet quality predicted lower metabolic risk.

Table 2a. Summary of dietary exposure, outcomes measured, and key findings in each of the three body weight/adiposity studies relevant to answering Question b (Qb).

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Rey-García et al.[188]	Nutri-Score food quality	Abdominal obesity	Less favorable Nutri-Score associated with 24% higher abdominal obesity risk per 10-unit increase
Han et al.[189]	AHEI, AMED (Mediterranean), DASH; food groups	BMI, weight, body composition; interaction with obesity polygenic risk score	Diet quality interacts with obesity PRS; healthier patterns reduce PRS-related anthropometric risk
Vaezi et al.[170]	MPF omnivorous vs MPF lacto-ovo-vegetarian (~13% UPF) vs habitual baseline (~50% UPF)	Weight, fat mass, adiposity, HOMA-IR, insulin sensitivity, lipid profile, blood pressure	Both MPF arms reduced weight (3.8 to 4.4 kg), improved HOMA-IR (~24%), and improved lipids vs baseline; no difference between MPF arms

Table 2b. Summary of dietary exposure, outcomes measured, and key findings in each of the three T2DM/glycemia studies relevant to answering Question b (Qb).

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Hassani Zadeh et al.[190]	Prudent, Mediterranean, vegetable, Western patterns	Gestational diabetes mellitus	Mediterranean reduced GDM risk by 30%; prudent by 22%; vegetable by 14%; Western increased risk
Ginos et al.[171]	Whole grains + legumes + fruit/veg vs refined grains + added sugars (eucaloric)	Circulating bile acids (TLCA, TCA, GCA), HOMA-IR, CRP	Higher plasma TLCA, TCA, GCA bile acids on whole-grain diet vs refined-grain diet; HOMA-IR differences

Table 2c. Summary of dietary exposure, outcomes measured, and key findings in each of the five cardiovascular disease/events studies relevant to answering Question b (Qb).

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Chareonrungrueangchai et al.[191]	Mediterranean, DASH, HEI, aHEI	CVD incidence, coronary heart disease, stroke, CV mortality, all-cause mortality	Mediterranean strongest for CVD prevention; benefit for all-cause and CV mortality inconsistent
Angelino et al.[192]	Fruit and vegetable intake	CVD, age-related cataract, cancer, T2DM, hypertension, other health outcomes	Strongest evidence for reduced CVD and reduced age-related cataract with higher F&V intake
Bechthold et al.[193]	12 a priori food groups	Coronary heart disease, stroke, heart failure (with dose-response)	Specific food groups (whole grains, fish, fruits and vegetables) protective for CHD, stroke, heart failure

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Lim et al.[194]	"High-quality" composite dietary patterns	CVD incidence, CVD mortality	Higher-quality patterns inversely associated with CVD risk
Côté et al.[195]	5 machine-learning derived dietary pattern	CVD events	One pattern ("Sweets and snacks," dominated by UPF) positively associated with CVD incidence; other four patterns null

Table 2d. Summary of dietary exposure, outcomes measured, and key findings in each of the three cardiovascular biomarkers studies relevant to answering Question b (Qb).

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Macknin et al.[196]	Plant-based vs Mediterranean vs AHA	LDL-C (primary); HDL, total cholesterol, triglycerides, BP, novel risk markers (myeloperoxidase, TMAO), BMI	All three diets produced similar significant improvements in LDL, CV risk markers, BP, and anthropometric measures
Rostgaard-Hansen et al.[197]	DQS (Danish dietary quality score)	Serum lipids, HbA1c, hs-CRP, systolic and diastolic BP, waist circumference, BMI, visceral fat, total fat mass	Higher DQS associated with lower lipids, HbA1c, homocysteine, BP, and IHD risk
Bhat et al.[198]	A priori and a posteriori dietary patterns	Carotid intima-media thickness (subclinical atherosclerosis)	Mostly null associations between dietary patterns and CIMT

Table 2e. Summary of dietary exposure, outcomes measured, and key findings in each of the two aging and mortality (not included in narrative below) studies relevant to answering Question b (Qb).

Study (Year)	Diet Exposure	Outcomes Measured	Key Finding
Assmann et al.[199]	PNNS-GS (French nutritional guideline score)	Healthy aging composite (chronic disease-free, functional status, mental health, perceived health)	Higher PNNS-GS associated with healthy aging, partially mediated by lower BMI
Etesami et al.[200]	oPDI, hPDI, uPDI plant-based diet indices	All-cause mortality, CVD mortality, CHD mortality, cancer mortality	Higher oPDI and hPDI significantly reduced all-cause, CVD, CHD, and cancer mortality

The evidence was strongest for the link between diet quality and body weight/adiposity in the studies provided. In a U.S. crossover feeding trial of older adults, two minimally processed diets aligned with the DGA (an omnivorous pork-based diet and a lacto-ovo-vegetarian lentil-based diet) produced 3.8 to 4.4 kg of weight loss along with broad cardiometabolic improvements, with no difference between the two protein sources.[170] The authors observed that the benefit appeared to come from adherence to a high-quality, DGA-aligned dietary pattern, regardless of protein source. In Spanish older adults, a less favorable Nutri-Score was associated with 24% higher abdominal obesity risk per 10-unit increase in score.[188]

The DSHS-provided studies also included those evaluating incident T2DM, glycemia, cardiovascular disease events, and cardiovascular-related biomarkers. For incident T2DM, in a cohort of Brazilian adults, participants whose diets emphasized whole and minimally processed foods (NOVA Groups 1 and 2) had a 41% lower T2DM risk over six years.[168] Relatedly, a systematic review reported that the Mediterranean diet reduced gestational diabetes risk by 30% while the Western diet increased it.[190] For glycemic markers, American adults on an eucaloric diet rich in whole grains improved insulin resistance compared with a refined-grain diet.[171] For cardiovascular events, an umbrella review in the pool and a large Asian meta-analysis both reported that higher-

quality dietary patterns are inversely associated with CVD risk, thought they measure diet quality in different ways.[191,194] For cardiovascular biomarkers, the Danish Dietary Quality Score predicted lower lipids and lower blood pressure.[197] Also, a pediatric randomized controlled trial comparing three healthy eating patterns (plant-based, Mediterranean, American Heart Association diets) in children with obesity found all arms produced similar improvements in LDL and cardiovascular risk markers.[196]

We did not assign a formal I-V grade for Qb. The exposure definitions across these studies are too heterogeneous to allow direct comparison. For example, a study using the Mediterranean Diet Index measures something different from a study using a dietary pattern derived by machine learning. Outcomes are equally heterogeneous, concentrated in body weight and cardiovascular outcomes with few studies on T2DM and none on liver disease. Given the limitations, the consistency in direction is reassuring and aligns with decades of established dietary guidance, but it does not lend itself to evaluation against the TNAC's five grading criteria. A future TNAC review of dietary quality applying a consistent exposure framework would allow Qb to be graded with the same rigor as Qa.

Limitations

Several limitations of this review warrant consideration consisting of both methodological limitations of the review process and limitations within the evidence base itself.

Methodological limitations of the review

First, the SME team was not involved in the search, and details of the executed search were not shared. The working group received the search output without documentation of full details as previously described. Thus, the SME team cannot independently replicate or audit the search. Some of the studies provided were not relevant to either question the SME team was tasked with answering. Examples include Ballena-Caicedo et al. (dyslipidemia and occupational factors with no UPF measurement)[201] and Walton et al. (caregiver feeding practices in very low birthweight infants).[202] These were excluded from this chapter but raise questions about the search methodology. Relatedly, the SMEs identified more than 30 additional relevant studies based on their independent knowledge of the literature. The working group prioritized 13 additions. The most consequential gap was in causal evidence: only four controlled-feeding RCTs of UPF versus minimally processed diets exist in the published literature. HHS supplied two,[142,150] and the SME team added the other two.[149,151] The search also lacked key meta-analyses that were added.

Conclusions and Recommendations

The TNAC reviewed 88 studies that included those provided by DSHS and supplemented by the SMEs and graded the body of evidence for the link between ultra-processed dietary patterns for specific metabolic health outcomes against the TNAC's five criteria. The evidence linked higher UPF intake to several adverse metabolic outcomes, and no evidence of metabolic benefit from UPF consumption was identified. Evidence is strongest for the association between ultra-processed dietary patterns with body weight and adiposity (Grade I) and risk of T2DM (Grade I). The evidence base for cardiovascular disease and events (Grade II) is consistent and growing, but evidence for liver disease is more limited (Grade III). Evidence for intermediate biomarkers (glycemia, lipid panels, blood pressure) is also limited (Grade III) with inconsistent results across studies.

Cancer and Dietary Pattern

The TNAC recognizes cancer as a major contributor to morbidity and mortality in Texas and acknowledges the substantial body of evidence linking overall dietary patterns, obesity, alcohol consumption, highly processed meat consumption, and other nutrition-related factors to cancer risk and survivorship outcomes. Due to limitations in available time and resources during development of the inaugural report, a comprehensive review of the nutrition and cancer literature was not completed for inclusion in this edition.

Given the importance of this topic and the rapidly evolving evidence base, the TNAC recommends that the relationship of dietary pattern with cancer prevention, management of treatment-related symptoms, and survivorship be prioritized for expanded review in future updates of the report. This review should consider both primary prevention and the role of nutrition in supporting health outcomes among cancer survivors, with attention to populations disproportionately affected by cancer-related disparities.

Brain Health and Dietary Pattern

To understand the current science on how diet affects brain health, DSHS librarians searched the scientific literature using the specified search strategy. They identified eight articles on brain health and UPF consumption and six articles on brain health and dietary patterns or intake of minimally and unprocessed foods. We added three studies that met the review criteria but were not returned by the search: a UK Biobank dementia cohort by Li et al.,[203] the MIND diet randomized trial by Barnes et al.,[204] and a MIND-style polyphenol snack trial by Clark et al.[205] identified through a parallel Food

Is Medicine scoping review. This brings the total to nine UPF studies and eight dietary quality studies.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of brain health conditions across all life stages?

Higher UPF intake is associated with faster cognitive decline and higher risk of dementia, including Alzheimer's disease, in adults and older adults. (Fair evidence)

Substituting unprocessed or minimally processed foods for UPF is associated with lower risk of dementia and cognitive impairment. (Fair evidence)

Higher UPF intake is associated with higher risk of Parkinson's disease. (Limited evidence)

Higher UPF intake is associated with higher risk of stroke. (Limited evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and brain health conditions across all life stages?

In observational studies, higher dietary quality or adherence to a healthy dietary pattern is associated with lower risk of dementia, Parkinson's disease, and cognitive decline in older adults. (Fair evidence)

Randomized trials to date have not shown that improving dietary quality slows cognitive decline, though trial duration was short, and the comparison diets were relatively healthy. (Limited evidence)

Summary of Evidence

Brain Health and UPF Consumption

This review of UPF and brain health included seven prospective cohort studies, one systematic review with meta-analysis, and one narrative review. Most of the cohort studies and the meta-analysis received preliminary positive ratings; the remaining studies were rated neutral, and the narrative review is addressed separately below.

Cognitive decline and dementia carried the most evidence. Gomes Gonçalves et al. followed 10,775 Brazilian adults in the ELSA-Brasil cohort and found that UPF intake above the lowest quartile was associated with about 28% faster global cognitive decline and 25% faster executive-function decline over a median of eight years.[206] Bhave et al. reported in the biracial U.S. REGARDS cohort that each 10%increase in relative UPF intake was associated with higher risk of cognitive impairment (HR 1.16), while greater intake of unprocessed or minimally processed foods was associated with lower risk (HR 0.88); these associations held independent of adherence to the Mediterranean, DASH, and MIND patterns.[207] Li et al. found in 72,083 UK Biobank adults that higher UPF intake predicted incident dementia, and that replacing 10% of UPF with unprocessed or minimally processed foods was associated with a 19% lower risk of dementia and a 22% lower risk of vascular dementia.[203] Weinstein et al. reported in the Framingham Offspring cohort that, among adults under 68 years of age, each daily serving of UPF was associated with a 13% higher risk of Alzheimer's disease, with no significant association at older baseline ages.[208] Gu et al. linked high UPF intake to incident dementia (HR 1.37) in the UK Biobank and, in a neuroimaging subsample, to reduced subcortical volume and widespread cortical thinning.[209] K. Zhang et al. found that higher midlife UPF intake was associated with more subjective cognitive complaints decades later among women in the New York University Women's Health Study.[210] Pooling this literature, Henney et al. reported in a meta-analysis of 10 observational studies (867,316 adults) that high versus low UPF intake was associated with a 44% higher relative risk (RR) of dementia (RR 1.44), although statistical heterogeneity was very high.[211]

Two cohorts addressed Parkinson's disease. Chen et al. followed 121,440 UK Biobank adults and found that the highest quartile of UPF intake, compared with the lowest, was associated with higher risk of prodromal features, incident Parkinson's disease (HR 1.32), and Parkinson's death (HR 3.11).[212] Gu et al. similarly reported higher risk of Parkinson's disease (HR 1.76) with high UPF intake.[209] Bhave et al. was the only study to examine stroke and found that higher UPF intake was associated with higher stroke risk (HR 1.08), with a stronger association among Black than White participants.[207]

Lehoczki et al. is a narrative review describing the mechanisms by which Western dietary patterns, including UPF, may accelerate cognitive and neurovascular aging.[213] Because it is not a systematic review and does not quantify UPF intake, it likely falls outside the study designs specified for this review, and we did not weight it in grading.

In summary, higher UPF intake was associated with faster cognitive decline and higher risk of dementia across several large prospective cohorts and a meta-analysis, with a reasonably consistent direction of effect and a supporting substitution analysis. Evidence for Parkinson's disease came from two cohorts that drew on overlapping UK

Biobank data, and evidence for stroke came from a single cohort. All studies were observational, no randomized trials of UPF reduction have been conducted, and the one meta-analysis showed high heterogeneity. We therefore rated the evidence fair for the association between UPF intake and cognitive decline and dementia in adults and limited for Parkinson's disease and stroke.

Brain Health and Dietary Quality/Consumption of Minimally Processed and Unprocessed Foods

This review included two systematic reviews with meta-analysis, two additional cohort analyses, and four randomized or cluster-randomized trials. The evidence fell along a clear line: observational studies generally found that higher dietary quality was associated with better brain health, while the randomized trials did not show a cognitive benefit.

On the observational side, Liu, Gao, et al. reported in a meta-analysis of 12 prospective cohorts (66,930 adults) that adherence to a healthy dietary pattern was associated with lower risk of overall dementia (RR 0.82) and Alzheimer's disease (RR 0.61).[214] Liu, Jensen, et al. found, in a cohort of 3,653 older adults and a meta-analysis of 140,617 individuals, that higher diet quality was associated with lower risk of Parkinson's disease (pooled RR 0.64).[215] Chen et al. followed 356 older adults in Taiwan and found that those who maintained consistently high dietary quality over six years had better cognitive performance than those whose diets changed.[216] Berendsen et al. was the exception among the observational studies: in a pooled analysis of 21,837 older adults from three European and American cohorts, a higher Healthy Diet Indicator score was not associated with slower cognitive decline.[217]

On the trial side, the MIND diet trial by Barnes et al. randomized 604 older adults at elevated dementia risk to the MIND diet or a control diet, both with mild caloric restriction, and found no difference in cognition or brain MRI after three years; cognition improved modestly in both groups, with each losing about five kilograms.[204] Mossavar-Rahmani et al. tested an anti-inflammatory Multicultural Healthy Diet in 290 middle-aged adults in the Bronx and likewise found no difference in global cognition at nine months, even though participants adhered to the diet.[218] Clark et al. randomized 180 older adults with low education, most of them Black and recruited from a safety-net system, to home-delivered MIND-style polyphenol snacks and online cognitive training; cognition improved in all arms but did not differ between them, consistent with the other diet trials, while extending the evidence to a high-risk population that the MIND trial did not reach.[205] Zülke et al. reported that a multidomain lifestyle program improved diet quality in older adults at dementia risk, mainly through increased fruit and vegetable intake, but did not measure cognitive outcomes.[219]

Observational studies were consistent that higher dietary quality and greater intake of minimally and unprocessed foods are associated with lower risk of dementia, Parkinson's disease, and cognitive decline. The randomized trials available to date have not confirmed a cognitive benefit, but they were limited by short follow-up, comparison diets that were themselves relatively healthy, and weight loss in both arms that may have narrowed the contrast. We rated the observational association fair, and the causal evidence from trials limited.

Summary

Across both questions, the evidence points in a consistent direction, although its strength varies by outcome and study design. Higher intake of UPF is associated with faster cognitive decline and higher risk of dementia in adults and older adults, with weaker and more preliminary signals for Parkinson's disease and stroke. Higher dietary quality and greater reliance on minimally and unprocessed foods are associated with lower risk of dementia and cognitive decline in observational studies, although randomized trials have not yet shown that improving diet slows cognitive decline. The one cohort that directly modeled food substitution found that replacing UPF with unprocessed or minimally processed foods was associated with lower dementia risk, which ties the two questions together.

Taken together, the literature supports encouraging a dietary pattern built on fruits, vegetables, whole grains, fish, and other minimally processed foods, and limiting UPF, to support brain health across the life course. Longer randomized trials, and work to identify which features of UPF drive risk, are needed to strengthen causal conclusions.

Mental Health and Dietary Pattern

To better understand the current science on the impact of dietary patterns on mental health, DSHS librarians conducted a search of scientific literature according to the specified search strategy. They identified 5 articles related to mental health and consumption of UPF. They found nine articles related to mental health and dietary patterns or intake of minimally/unprocessed foods.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of mental health conditions across all life stages?

Limited evidence suggests UPF intake is associated with higher risk of depressive symptoms and other mental health conditions in adults. (Limited evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and mental health conditions across all life stages?

Nutrient-dense diets/high quality diets are associated with lower risk of depressive symptoms in children, adolescents, adults, and older adults. (Strong evidence)

Nutrient-dense diets/high quality diets are associated with lower risk of ADHD symptoms in children and adolescents. (Fair evidence)

Summary of Evidence

Mental Health Conditions and UPF Consumption

This evidence review investigates the relationship between mental health conditions and UPF consumption and included two positively rated prospective cohort studies by Ferreria et al. [220] and Wu et al.,[221] one neutrally rated prospective cohort study by Arshad et al.,[222] a positively rated cross-sectional study by Sen et al.,[223] and a neutrally rated cross-sectional study by Akin et al.[224] Ferreria et al. and Arshad et al. addressed depressive symptoms in a diverse, Brazilian population of adults and an almost entirely white population of adults, British Civil servants.[220,222] Both studies found that the highest quintile of UPF consumption was associated with higher depressive symptoms, with Arshad et al. finding a high threshold amount (795 grams) associated with symptoms.[222]

The third prospective cohort study by Wu et al. assessed suicide attempts in a population of almost entirely white, British adults with higher-than-average education levels.[221] They found a dose response relationship between UPF consumption and suicide risk and a small possible effect for inflammation as a mediator for this risk.

Sen et al. evaluated 683 adults with T2DM in Quebec, Canada for their depressive symptoms, diabetes complications, and anti-depressant use.[223] They found those with the highest UPF intake and high depressive symptoms had the highest risk for diabetes complications. They found the highest risk for complications when high depressive symptoms were combined with anti-depressant use and high UPF consumption. However, the confidence interval for the finding of high UPF intake and high depressive symptoms being linked to higher risk for complications included 1.0, indicating a possibly insignificant relationship.

Akin et al. found in a small (n=326), mostly female population of adult, Turkish shift workers that longer shifts were associated with higher UPF intake.[224] In addition, longer shifts were associated with higher anxiety and depression.

In summary, the most consistent finding supported by the strongest, cross-sectional evidence was that UPF intake was associated with higher depressive symptoms, particularly at very high levels but shown only in Brazilian[220] and British[222] adults. Findings regarding depression and diabetes complications[223]; UPF and suicide risk[221]; shift work and UPF intake and depression/anxiety[224] were limited to single studies.

Because of the limited nature of these three studies, we confined our findings to the relationship between UPF and depressive symptoms in adults and rated the evidence limited.

Mental Health Conditions and Dietary Pattern/Consumption of Minimally Processed and Unprocessed Foods

The review of the relationship between mental health conditions and dietary patterns with consumption of minimally processed and unprocessed foods included nine studies, all of which were systematic reviews. Five studies also incorporated a meta-analysis. All but one study had a positive rating; Khalid et al. had a neutral rating.[225] With the exception of one study that focused on ADHD,[226] the other studies assessed the relationship between healthy dietary patterns, particular dietary quality scores, or particular foods regarded as healthy and depressive symptoms. Three of the studies focused on children and adolescents and depressive symptoms.[225,227,228] The remaining studies on depressive symptoms evaluated relationships with UPF intake in adults.

The study by da Silva et al. found that higher intake of unhealthy foods was associated with higher depressive symptoms in 21 studies evaluated for the systematic review and four for the meta-analysis, which were conducted across the world but with none in the U.S.[227] An unhealthy snacking pattern was not found to be associated with higher depressive symptoms. Khalid et al. identified 20 studies across the world, including in the U.S., with 109,533 children or adolescents represented and found that healthier diets were associated with better mental health and fewer depressive symptoms but with some inconsistencies in findings and small effect sizes.[225] Tucker et al. found in 19 studies of more than 13,000 children and adolescents across the world, including the U.S., that healthier dietary patterns were associated with decreased depressive symptoms and better mental health.[228]

In the single study that assessed ADHD and diet in children and teens, Shareghfarid et al. found in 12 studies for the systematic review portion and six dietary pattern studies for the meta-analysis that healthy dietary patterns decreased the risk of ADHD;

Western dietary patterns increased the risk.[226] Sweetened beverages, desserts, processed meats, salt, and fried foods were associated with more ADHD symptoms. Fruits, vegetables, dairy, cereals, meat, pulses, and fish in general healthy dietary patterns were associated with lower risk in several studies.

Among the studies in adults, Fang et al. evaluated adherence to the EAT Lancet dietary pattern (a dietary pattern that emphasizes more sustainable, plant-based components) and found that highest adherence was associated with lower depressive symptoms, anxiety, and co-occurrence of depression and anxiety.[229] This finding resulted from eight unique studies representing more than 400,000 individuals across the world, primarily adults.

Głąbska et al. focused on the relationship between depressive symptoms and other mental health symptoms and fruit and vegetable intake.[230] Their review of 61 studies of adults across the world found significant associations of fruit and vegetable intake with improved mental health and optimism. Berries, citrus fruits, and green leafy vegetables showed stronger associations with improved mental health in some studies. Raw (vs. processed) fruits and vegetables were associated with better outcomes in some studies. They observed that benefits seemed to occur with consumption of ≥ five portions a day in some studies, with others reporting the strongest effects at six to eight servings a day.

In contrast, Molendijk et al. found in their evaluation of 29 studies of children, adults and older adults that vegetables and fish were more strongly associated with lower depressive symptoms.[231] In addition, they found that low-quality diets were not significantly associated with higher depression incidence, and studies controlling for baseline depression severity or using formal depression diagnosis did not show significant associations. Tuck et al. also found in their study of 33,645 of adolescents and adult worldwide that fruit and vegetable intake was associated with higher psychological well-being with vegetables having a strong relationship.[232] Wu et al. found in eight studies of 38,360 ages 18 to 101 that higher dietary quality was associated with lower risk of depression.[233]

Because of the consistent relationship among healthy dietary patterns (including vegetables, fruits, whole grains, fish) and lower depressive symptoms across the lifespan, we rated the evidence strong that healthy dietary patterns relying primarily on unprocessed and minimally processed foods may improve psychological well-being and reduce prevalence of mental health conditions. The conclusion about healthy dietary patterns and ADHD is emerging because there was only one systematic review and meta-analysis on this topic. However, the evidence was based on several studies and was highly suggestive of benefit.

Summary

Broadly, there is stronger and more consistent evidence that high quality dietary patterns, without consideration of level of processing but which tend to rely on unprocessed and minimally processed foods, may help to reduce risk of depressive symptoms. Individuals throughout the life cycle should be encouraged to eat a high-quality dietary pattern rich in fruits, vegetables, and other fresh foods to support good mental health. Evidence also suggests that high-quality diets are associated with lower risk of ADHD in children and adolescents. More limited evidence suggests that UPF intake is associated with higher risk for depressive symptoms in adults. While more research is needed on the aspects of UPF that may drive this relationship, based on the literature surrounding high quality diets, there is ample evidence to support a diet high in high quality, fresh foods.

Gastrointestinal Diseases and Dietary Pattern

To better understand the current science on the impact of dietary patterns on gastrointestinal health, DSHS librarians conducted a search of scientific literature according to the specified search strategy. They identified 12 articles related to gastrointestinal health and consumption of UPF. They found seven articles related to gastrointestinal health and dietary patterns or intake of minimally/unprocessed foods.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of gastrointestinal health conditions across all life stages?

Fair evidence suggests that high UPF intake is a strong, independent predictor for developing irritable bowel syndrome (IBS) and inflammatory bowel disease (Crohn's Disease and Ulcerative Colitis) in healthy adults. (Fair evidence)

For patients with a diagnosis of inflammatory bowel disease (IBD) that are currently symptom-free (in remission), consuming high amounts of UPF significantly increases the risk of relapse. (Fair evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and gastrointestinal health conditions across all life stages?

Nutrient-dense diets/high quality diets including minimally processed foods are strongly linked with a lower risk of developing Crohn's disease and IBS. (Fair evidence)

Summary of Evidence

Gastrointestinal Disease and Dietary Patterns

This evidence review investigated gastrointestinal disease and dietary patterns and included several prospective cohort studies, systematic reviews, meta-analyses, and one randomized controlled trial evaluating the relationship between dietary quality, minimally processed foods, and UPF consumption across IBD, IBS, functional constipation, and gastrointestinal cancer outcomes.

Among studies focused on UPF intake, Chen et al. evaluated more than 187,000 participants in the UK Biobank and found that higher intake of ultra-processed food was associated with increased risk of Crohn's Disease.[234] Similarly, Narula et al., in a systematic review and meta-analysis, found that higher consumption of processed and ultra-processed food was associated with greater risk of Crohn's Disease.[235] Almofarreh et al. additionally reported an association between fast food consumption and increased odds of IBD in both a case-control study and meta-analysis.[236]

Several studies also evaluated the relationship between healthier dietary patterns emphasizing minimally processed foods and gastrointestinal outcomes. Ho, Gao, et al. found in a large prospective cohort study that adherence to multiple healthy lifestyle behaviors, including higher dietary quality, was associated with substantially lower risk of developing IBD.[237] Similar findings were reported by Ho, Sun, et al. for IBS[238] and by Ho, Wang, et al. for functional constipation,[239] with healthier dietary patterns associated with lower incidence of both conditions.

Karimi et al., in a systematic review of observational studies, concluded that diet quality appears to play an important role in IBD severity and symptom burden, with more inflammatory dietary patterns associated with worse outcomes.[240] Meyer et al. similarly found through systematic review and meta-analysis that healthier dietary patterns may reduce risk of IBD (especially Crohn's Disease) and support disease prevention strategies.[241]

The randomized controlled trial by Limketkai et al. evaluated a natural whole-food dietary intervention in individuals with Crohn's Disease and found improvements in clinical remission and inflammatory markers, suggesting that dietary quality may influence disease activity and symptom control.[242]

A careful review of the recent, large-scale studies that track patient dietary patterns over years reveal two distinct clinical trends: 1) High intake of UPF increase risk for developing IBS and IBD (especially Crohn's Disease) and increase risk for relapse for patients in symptomatic remission; 2) Minimally processed dietary patterns protect health by lowering risk of developing both Crohn's Disease and IBS, acting as a form of primary prevention.

Notably, the strength of the evidence is overall rated as Level II (Fair) since the findings are based on highly reliable observational data but with standard limitations expected in nutrition science. Strengths include that the findings come from massive, well-respected health databases (like the UK Biobank). By tracking hundreds of thousands of people over many years, these studies clearly prove the timeline: dietary habits (UPF exposure or minimally processed food protection) happened *before* the gut diseases developed. However, because it is unethical to force a test group to consume highly processed diets just to see if they develop illness, researchers must rely on people self-reporting their daily meals. While standard practice, this observational approach means we cannot claim causation, only a very strong association. Finally, another key limitation in the currently available science is that most of this high-quality data comes from Europe. European food safety laws already restrict many of the artificial additives, dyes, and preservatives that are legally allowed in the United States. Therefore, the gut health risks seen in these European studies might underestimate the true risk for populations consuming American UPF.

Summary

Current observational evidence shows a clear, two-way relationship between how our food is processed and gastrointestinal health. Diets high in UPF consistently predict both the onset and the worsening of gastrointestinal diseases. Conversely, diets focused on high-quality, minimally processed foods are associated with a strong protective effect, actively lowering the risk of developing these diseases in the first place. Current public health guidance about UPF mostly focuses on obesity, diabetes, and heart disease. Guidelines and recommendations should include education and additional research about the impact on gastrointestinal health.

Immune System and Dietary Pattern

To better understand the current science on the impact of dietary patterns on immune health, the DSHS librarians conducted a search of scientific literature according to the specified search strategy. They identified three articles related to immune health and consumption of UPF. They found two articles related to immune health and dietary patterns or intake of minimally/unprocessed foods.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of immune disease across all life stages?

Fair evidence suggests diets high in UPF are associated with higher levels of conditions related to immune dysfunction such as allergy, RA, and psoriasis. (Fair evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and immune disease across all life stages?

Fair evidence suggests nutrient-poor diets or lower quality diets are associated with higher levels of inflammation, which could contribute to immune dysfunction and/or chronic illness. (Fair evidence)

Summary of Evidence

Immune Health and UPF Consumption

This evidence review explores the relationship between immune health and UPF consumption and included a systematic review by Berni Canani et al. which evaluated 55 studies[243]; a prospective cohort involving 121,019 participants by Peng et al.,[244] and a retrospective cohort involving 207,012 participants (1,869 cases with Rheumatoid Arthritis) by Zhao et al. [245] All three studies were rated positively by reviewers for quality. The paper by Berni Canani et al. focused on the relationship between pediatric allergy and UPF consumption with a secondary focus on exploring possible mechanisms, such as inflammation and gut microbiota.[243] Peng et al. evaluated the relationship between psoriasis, a skin condition that is autoimmune in nature, and UPF.[244] Zhao et al. assessed the risk of developing rheumatoid arthritis with UPF intake.[245] Both the Peng and Zhao studies used the same prospective cohort to address their research questions (the United Kingdom Biobank), whose participants are more than 95% white and middle-aged, with higher-than-average incomes and physical activity levels, which may limit the generalizability of findings to other regions, including the more diverse U.S. population.[244,245] The Berni Canani systematic review included studies across the globe but involved only children, thus its findings may not be relevant to adults with food allergies.[243]

We rated the evidence fair on the relationship between UPF consumption and immune health due to the large number of participants and studies. The studies addressed different conditions and outcomes and included psoriasis and rheumatoid arthritis

patients, but the studies were not based in the U.S. and not reflective of diverse populations, so the strength of evidence could not be rated higher. All studies were limited by inconsistencies on how health outcomes were assessed, which were primarily self-reported. All studies applied UPF classifications on food databases retrospectively. Thus, not all foods may have been correctly classified, and participants may have changed their diets over time.

Immune Health and Dietary Pattern/Consumption of Minimally Processed and Unprocessed Foods

The evidence review of the relationship between immune health and dietary pattern and consumption of minimally processed or unprocessed foods included a meta-analysis by Neale et al.[246] and a systematic review by Bujtor et al.[247] Neale et al.'s meta-analysis included 18 articles of adults across the world and assessed the relationship among a variety of dietary patterns and various biomarkers.[246] Only C-reactive protein (CRP) was found to be associated with lower values (reduced inflammation) with healthy dietary patterns. There were also trends for increased adiponectin (associated with adequate insulin sensitivity) with healthy dietary patterns. Bujtor et al.'s systematic review evaluated 53 studies from across the world and found healthy dietary patterns to be associated with decreased indicators of several markers of inflammation: CRP, IL-6, TNF-alpha.[247] Alternatively, Westernized diets (typically described as being higher in saturated fat and sugar-sweetened beverages) were associated with higher CRP and IL-6. Mediterranean diets and diets rich in vegetables, fruits, and whole grains were associated with lower CRP. Some studies reported no significant associations, particularly in populations with type 1 diabetes or obesity.

Although there were only two studies, they included reviews of large numbers of other studies, were rated positive quality, and primarily found similar outcomes, so we rated the evidence as fair. However, there were some inconsistencies in findings across populations, thus a strong rating was not selected.

Summary

There is less evidence on both high-quality, minimally processed diets and diets rich in UPF and their impact on immune function and immune-related disorders. The studies we reviewed showed inconsistencies in particular dietary components associated with inflammation and whether inflammation was strongly related to autoimmune conditions. More research is needed to better understand the relationship of autoimmune diseases with dietary patterns. However, eating diets rich in unprocessed and minimally processed foods as well as high quality diets can still be recommended to those with autoimmune conditions or chronic inflammation.

Reproductive Health and Dietary Pattern

To better understand the current science on the impact of dietary patterns on reproductive health, DSHS librarians conducted a search of scientific literature according to the specified search strategy. The literature review included 46 studies related to UPF consumption, minimally processed dietary patterns, and reproductive outcomes including gestational weight gain, gestational diabetes, preeclampsia, preterm birth, fetal growth, infant growth, fertility, polycystic ovary syndrome (PCOS, recently renamed as polyendocrine metabolic ovarian syndrome or PMOS, but referred to as PCOS in this report due to rooting in prior literature), and semen parameters.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed/minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of poor reproductive health outcomes across all life stages?

Fair evidence suggests higher UPF intake before or during pregnancy is associated with poorer reproductive and pregnancy-related outcomes, including lower diet quality, excessive gestational weight gain, higher risk of gestational diabetes and preeclampsia, and potentially adverse fetal or neonatal outcomes. Evidence is more limited for fertility, semen quality, embryonic growth, and offspring growth outcomes. (Fair evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and reproductive health outcomes all life stages?

Fair evidence suggests nutrient-dense/high-quality diets, including Mediterranean, DASH, Nordic, and other healthy dietary patterns, are associated with improved reproductive and pregnancy-related outcomes, particularly lower risk of gestational diabetes, improved gestational weight gain, and lower risk of preterm birth or small-for-gestational-age birth. Limited but promising evidence suggests dietary interventions may improve fertility outcomes in women with PCOS and semen parameters in men. (Fair evidence)

Summary of Evidence

Reproductive Health and UPF Consumption

The review included systematic reviews, prospective cohorts, cross-sectional studies, and randomized trials evaluating UPF intake or interventions that specifically reduced UPF consumption during the preconception, pregnancy, postpartum, or fertility periods. Overall, the strongest and most consistent evidence relates to pregnancy outcomes, particularly diet quality, gestational weight gain, gestational diabetes, preeclampsia, and fetal growth.

Several systematic reviews and large observational studies suggest that higher UPF intake during pregnancy is associated with poorer diet quality and adverse pregnancy-related outcomes. Akyakar et al., a systematic review of 12 studies, concluded that UPF intake during pregnancy negatively affects diet quality and gestational weight gain.[248] Paula et al., a systematic review of 61 studies including nearly 700,000 women, found that UPF-rich diets were associated with increased risk of gestational diabetes and preeclampsia.[249] Talebi et al., a systematic review of 54 studies including more than 550,000 individuals, similarly concluded that chronic and excessive UPF intake before and during pregnancy was associated with increased risk of gestational diabetes and preeclampsia, while noting the need for more precise UPF assessment and greater population diversity.[250]

Prospective cohort studies support these concerns but remain observational. Cummings et al., in a U.S. prospective cohort, found that UPF intake during pregnancy may be a modifiable risk factor for adverse maternal weight outcomes and inflammation.[251] Yang et al., in women with prior gestational diabetes, found that UPF consumption was associated with long-term weight gain and higher T2DM risk, even among women with higher overall diet quality.[252] Schenkelaars et al. found that higher UPF intake in the periconception period was associated with increased total homocysteine levels, a marker relevant to one-carbon metabolism and pregnancy outcomes.[253] Smit et al. found that periconceptional maternal UPF consumption was associated with smaller embryonic growth.[254]

However, evidence is not uniformly positive, and some intervention studies showed no significant effect on selected birth or infant outcomes. Baroni et al., a randomized controlled trial of lifestyle counseling among pregnant women with overweight, found no effect on neonatal adiposity or birth weight.[255] Santos et al. found no effect of NOVA-based nutrition counseling during pregnancy on infant growth at 6 months.[256] Whyte et al., a smaller RCT, found no significant associations between maternal UPF intake, gestational weight gain, and offspring outcomes.[257]

These studies suggest that intervention intensity, timing, adherence, and outcome selection may substantially affect findings.

The evidence related to male fertility and semen quality is promising but limited. Petre et al., a cross-sectional study of 358 individuals, found that greater adherence to a Mediterranean diet and lower UPF intake were associated with better semen profiles.[258] Preston et al. also reported that UPF consumption was detrimental for cardiometabolic and reproductive outcomes, regardless of excessive caloric intake.[151] These findings are biologically plausible but not sufficient to establish causality.

Overall, UPF evidence is most consistent for maternal diet quality and pregnancy metabolic outcomes. Evidence is weaker for downstream infant growth, fertility, male reproductive outcomes, and mechanistic pathways such as gut dysbiosis, placental inflammation, the maternal-fetal immune axis, and potential epigenetic mechanisms that may contribute to developmental programming of offspring health. Future research should clarify whether dietary patterns, particularly UPF exposure during preconception and prenatal periods, influence long-term health trajectories across generations through these pathways.

Reproductive Health and Dietary Pattern/Consumption of Minimally Processed and Unprocessed Foods

The evidence review included multiple studies evaluating dietary quality, Mediterranean-style dietary patterns, DASH-style dietary patterns, Nordic dietary recommendations, healthy eating interventions, and preconception lifestyle interventions. Compared with the UPF literature, this body of evidence more often evaluated established dietary patterns rather than degree of processing alone.

The strongest evidence relates to gestational diabetes. Gao et al., a review of 19 studies including more than 108,000 participants, found that higher diet quality before and during pregnancy reduced the risk of gestational diabetes, while poorer diet quality increased risk.[259] Mijatovic-Vukas et al., a systematic review of 40 studies including more than 30,000 pregnant women, found that diets resembling Mediterranean, DASH, and Alternative Healthy Eating Index patterns were associated with lower gestational diabetes risk.[260] Melero et al., a randomized controlled trial in Hispanic women living in Spain, found that a Mediterranean diet-based intervention reduced gestational diabetes and several adverse maternal-fetal outcomes.[261] Fagherazzi et al., a small RCT in women with pre-gestational diabetes, found that a DASH diet may support glycemic control while also reducing UPF consumption.[262]

Several studies also support healthier dietary patterns for gestational weight gain and fetal growth, although findings are mixed. Broekhuizen et al., a randomized trial, found

that healthy eating and physical activity promotion was the preferred strategy for limiting gestational weight gain and was cost-effective.[263] Sartorelli et al., an RCT of NOVA-based nutritional counseling plus physical activity encouragement, found that the intervention prevented excessive gestational weight gain in pregnant women with overweight.[264] Crivellenti et al. found that adherence to counseling goals was associated with lower total and LDL cholesterol.[265] Dieberger et al. found that a lifestyle intervention in pregnant women with obesity attenuated fetal growth, reaching significance only in male offspring.[266]

For preterm birth and birth size outcomes, systematic reviews and cohort studies suggest benefit from healthier dietary patterns. Chia et al., a systematic review and meta-analysis including 36 studies and more than 167,000 participants, found that greater adherence to healthy dietary patterns during pregnancy was associated with lower risk of preterm birth, although findings for birth weight and small- or large-for-gestational-age were not consistent.[267] Gete et al., a systematic review of 40 articles, found that better maternal diet quality characterized by higher intake of vegetables, fruits, whole grains, dairy, and protein foods may reduce risk of preterm birth and small-for-gestational-age birth.[268] Raab et al., a cohort study of 1,738 women, found that low dietary quality in early pregnancy may increase the chance of preterm birth.[269]

The evidence for fertility and assisted reproductive outcomes is promising but less definitive. Shang et al., a meta-analysis of 20 RCTs including 1,113 participants, found that dietary interventions improved fertility outcomes in women with PCOS.[270] Winter et al., a systematic review of dietary patterns and fertility outcomes, found preliminary evidence that dietary patterns or whole diets may improve pregnancy and live birth rates, but heterogeneity limited conclusions about which specific dietary patterns are most beneficial.[271] Van Elten et al., an RCT in obese infertile women, found that a preconception lifestyle intervention reduced high-calorie snack and beverage intake and increased physical activity.[272]

For male reproductive health, Petre et al., a cross-sectional study of 300 males, found that higher adherence to the Mediterranean diet was associated with better semen parameters, including sperm count, concentration, morphology, and progressive motility.[273] These findings are consistent with the later UPF-focused Petre et al. study, but the evidence remains limited by observational design.[258]

Several studies also highlight implementation challenges. Van Dijk et al. found that a mobile preconception coaching intervention improved nutritional behaviors, especially vegetable intake.[274] Wilkinson et al. found that an adapted digital intervention improved vegetable intake, fiber diet quality, and total diet quality but did not improve

physical activity or gestational weight gain.[275] Pauley et al., a very small RCT, suggested that brief exposure to a gestational weight gain intervention improved motivational determinants, but the sample was too small to support strong conclusions.[276] Ooi et al. also noted that validated diet quality indices for pregnant women remain limited, especially indices tailored to pregnancy-specific nutrient and food safety needs.[277]

Summary

Overall, the reproductive health literature supports diets lower in UPF and higher in nutrient-dense, minimally processed foods, which are generally associated with more favorable health outcomes. In reproductive health, the strongest evidence relates to pregnancy metabolic outcomes, especially gestational diabetes, gestational weight gain, and preeclampsia risk. Healthy dietary patterns such as Mediterranean, DASH, Nordic, and other well-studied, high-quality dietary patterns appear beneficial before and during pregnancy and may reduce risk of preterm birth and some adverse fetal outcomes.

Evidence is more limited for fertility, assisted reproductive technology outcomes, semen parameters, embryonic growth, postpartum outcomes, and infant growth. Some findings are promising, particularly for PCOS-related fertility outcomes and Mediterranean diet adherence in relation to semen quality, but these areas require more rigorous prospective studies and randomized trials. Several intervention studies showed no effect on selected neonatal or infant outcomes, suggesting that more intensive, better-timed, and more targeted nutrition interventions may be needed.

Based on the current evidence, reproductive-age individuals and pregnant patients can reasonably be encouraged to consume dietary patterns rich in vegetables, fruits, whole grains, legumes, nuts, lean proteins, and other minimally processed foods while limiting reliance on UPF. These recommendations align with broader chronic disease prevention goals and may be especially important during the pre-conception and pregnancy periods, when dietary patterns can affect both maternal and offspring health.

Mortality and Dietary Pattern

To better understand the current science on the impact of dietary patterns on mortality, DSHS librarians conducted a search of scientific literature according to the specified search strategy. They identified six articles related to mortality and consumption of UPF. They found five articles related to mortality and dietary patterns high in the intake of minimally and unprocessed foods.

Research Questions and Answers (Evidence Grades)

Question 1: What is the relationship between dietary patterns or overall intake of "real foods" (unprocessed and minimally processed) compared to those reliant on processed and UPF (NOVA Group 4) and risk of all-cause or specific-cause mortality across all life stages?

Fair evidence suggests diets high in UPF are associated with higher risk of all-cause mortality and cardiovascular disease mortality. There is not enough evidence to assess UPF intake and other cause-specific mortality. (Fair evidence)

Question 2: What is the relationship between nutrient-dense diets or high dietary quality diets (regardless of level of processing) and all-cause or specific-cause mortality across all life stages?

Strong evidence suggests nutrient-dense and high dietary quality diets are associated with lower all-cause mortality. (Strong evidence)

Summary of Evidence

Mortality and UPF Consumption

This evidence review investigates the relationship between mortality and UPF consumption; it included one positive systematic review,[278] four positively rated prospective cohort studies,[279–282] and one positively rated cross-sectional study.[283] The meta-analysis by Boushey et al. included three articles including adults in the U.S., Spain, and France.[278] The meta-analysis found ultra-processed food consumption was consistently associated with increased all-cause mortality risk across the three studies.

Du et al. found in a sample of 27,670 Swedish adults with a mean percentage UPF intake of just 13% of the diet that UPF intake showed a nonlinear positive association with all-cause mortality, with more pronounced associations in females.[279] The association was linear in females and J-shaped in males. Each standard deviation (SD) increment in UPF intake was associated with increased premature mortality (HR 1.06; 95% CI 1.03-1.09), CVD mortality (HR 1.05; 95% CI 1.01-1.08), and respiratory disease mortality (HR 1.08; 95% CI 1.01-1.15). No significant association was found for cancer mortality. They uniquely assessed the metabolic signature for UPF consumption (93 metabolites) and found it was positively associated with all-cause mortality risk (HR per 1 SD 1.23; 95% CI 1.06-1.42).

L. Wang, Steele, et al. also found in a diverse sample of 38,148 U.S. adults in the NHANES study and the National Death Index that every 10% of energy from UPF was

associated with a six percent increased all-cause mortality risk in model three (HR 1.06; 95% CI 1.00-1.11).[280] The association was stronger in models that did not account for dietary quality. However, in contrast to the previously described prospective cohort by Du et al., no significant associations were observed for cardiometabolic disorder mortality. Similarly to Du et al., no associations were found for UPF intake and cancer mortality.

Y. Wang et al. found in a mostly white sample of 172,225 British adults a smaller effect of UPF consumption.[282] Every 1 serving/day of UPF was associated with a two percent increase in all-cause mortality risk (HR 1.02; 95% CI 1.01, 1.03). UPF sources associated with increased all-cause mortality risk included plant-based items, animal-based items, ready-to-eat processed soups, savory snacks, artificial sweeteners, and beverages. Breakfast cereals were inversely associated with all-cause mortality risk. Associations between UPF intake and mortality risk were mediated by biological aging. In contrast to the previous 2 prospective cohort studies, every 1 serving/day was associated with increased cancer mortality risk (HR 1.02; 95% CI 1.01, 1.03). Similarly to the previous studies, CVD mortality risk (HR 1.04; 95% CI 1.02, 1.06) was increased, as was acute myocardial infarction mortality risk (HR 1.04; 95% CI 1.01, 1.08).

In a study by L. Wang, Pan, et al. of 77,060 adults in U.S. Southern states who were 65% Black, every 10% by weight of UPF was associated with a two percent increase in all-cause mortality risk in one model (HR 1.02; 95% CI 1.01, 1.03), which was not statistically significant in two other models.[281] No associations were observed between UPF and cancer mortality or CHD mortality in any model. However, UPF was significantly associated with diabetes mortality risk across all three models; model three HR 1.09 (1.04, 1.15).

González-Gil et al. also found a positive relationship between UPF intake and mortality in their cross-sectional study of 428,728 adults across 10 European countries.[283] UPF (% grams/day) were positively associated with all-cause mortality (HR per 1 SD 1.04; 95% CI 1.02, 1.05). UPF intake was also positively associated with circulatory disease mortality (HR 1.09; 95% CI 1.07, 1.12), cerebrovascular disease mortality (HR 1.11; 95% CI 1.05, 1.17), ischemic heart disease mortality (HR 1.10; 95% CI 1.06, 1.15), digestive disease mortality (HR 1.12; 95% CI 1.05, 1.20), and Parkinson's disease mortality (HR 1.23; 95% CI 1.06, 1.42). Similarly to three of the other studies, no associations were found between UPF and mortality from cancer.

Because all studies evaluated, including adults from many countries and some with highly diverse samples, showed a small, but consistent effect of UPF intake and all-cause mortality, we rated the level of evidence fair for a relationship between UPF

intake and all-cause mortality. Five of the six studies also found a small but consistent relationship between cardiovascular-related mortality and UPF intake. However, other causes were less consistent across studies, with just one study in British adults finding a relationship between cancer-mortality and UPF intake. Thus, we did not make statements regarding other cause-specific mortality and UPF intake.

Mortality and Dietary Pattern/Consumption of Minimally Processed and Unprocessed Foods

The evidence review of the relationship between mortality and dietary pattern/consumption of minimally processed and unprocessed foods included five studies. All were positively rated; three were systematic reviews, with one including a meta-analysis and one a prospective cohort with meta-analysis. All assessed the relationship between healthy dietary patterns or dietary quality and mortality risk.

Boushey et al.'s systematic review included 53 studies of adults across the world, including the U.S.[278] They found dietary patterns rich in vegetables, legumes, nuts, whole grains, unsaturated oils, fish, and lean meat or poultry were associated with decreased all-cause mortality. Protective patterns were also low in red and processed meat, high-fat dairy, refined carbohydrates, and sweets. Greater adherence to Mediterranean, DASH, and plant-based dietary patterns was associated with lower mortality risk.

English et al. conducted a systematic review that included 6,550,664 adults across 153 studies (one RCT and 152 observational studies) from numerous countries.[284] There was strong evidence that nutrient-dense dietary patterns were consistently associated with reduced all-cause mortality in adults and older adults. Protective patterns were characterized by higher intake of vegetables, fruits, legumes, nuts, whole grains, unsaturated vegetable oils, fish, and lean meat or poultry. Protective patterns were also relatively low in red and processed meat, high-fat dairy, refined carbohydrates, and sweets. Lower all-cause mortality risk was observed across DASH, Mediterranean, and healthy *a posteriori* dietary pattern analyses. Associations were stronger when healthy dietary patterns were combined with other healthy lifestyle behaviors such as nonsmoking and physical activity.

Similarly, a systematic review and meta-analysis of 3,277,684 participants across 113 studies and several continents conducted by Morze et al. found higher diet quality was associated with a 20% lower risk of all-cause mortality.[285] Higher diet quality was associated with lower risk of cardiovascular disease (20%), cancer (14%), T2DM (19%), and neurodegenerative disease (18%). Among cancer survivors, higher diet quality was associated with lower all-cause mortality (17%) and cancer mortality

(18%). Similarly, in an older meta-analysis by Onvani et al. of 992,199 adults, high dietary quality was associated with a 23% lower all-cause mortality risk (RR = 0.77); 23% lower cardiovascular mortality risk (RR = 0.77); and 17% lower cancer mortality risk (RR = 0.83).[286] Finally, Shivappa et al. found in 7,627 participants in the Whitehall II cohort and 91,520 participants in a meta-analysis that higher dietary quality was associated with reduced all-cause mortality (HR = 0.82; 95% CI 0.76–0.88) and more pro-inflammatory diets were associated with increased all-cause mortality (HR = 1.18; 95% CI 1.08–1.29).[287]

Because of the consistent relationship between higher dietary quality and healthy dietary patterns (such as DASH, Mediterranean, etc.) and reduced all-cause mortality, we graded the evidence as strong. Few of the studies assessed cause-specific mortality, so no statement about these causes was included.

Overall Summary

There is strong and consistent evidence that high quality diets, without consideration of level of processing, but which tend to rely on unprocessed and minimally processed foods, reduce risk of early mortality and the conditions and diseases that lead to early mortality. While there are inconsistences in the literature about whether these diets help to prevent mortality due to cancer, there is consistent evidence that they help to prevent early death related to cardiovascular disease. Evidence regarding the relationship between UPF and mortality is less available, but based on the literature surrounding high quality diets, there is ample evidence to support a diet high in high quality, fresh foods.

Limitations in the Evidence Base for Diet and Health

There are limitations of the NOVA classification system. All studies used to answer Q1 used the NOVA classification system, which is the most widely used tool for categorizing UPF in research, but it has been criticized as set forth previously in this report. Because NOVA is defined by the nature and purpose of industrial processing rather than nutrient composition, products that consumers and dietitians perceive as relatively healthy (e.g., flavored yogurts, whole wheat sandwich bread, some plant-based dairy analogs) end up in the same category as sodas and packaged desserts. As the DGA Foundation Report noted, the breadth of the NOVA Group 4 category would be expected to dilute observed associations with poor cardiometabolic outcomes.[161] In other words, including items traditionally viewed as healthy and excluding known unhealthful items biases risk estimates toward the null. The fact that studies still consistently report adverse associations suggests the estimates are likely conservative.

Dietary assessment is always prone to a risk of error or bias. This is particularly true when measuring degree of processed food in a diet. Most studies measured UPF intake using food frequency questionnaires (FFQs) or 24-hour diet recalls. Historically, FFQs were not designed to capture degree of processing, and most of the reviewed literature relied on retrospective classification of FFQ data, an obvious limitation in the field. The two primary U.S. 24-hour recall tools (ASA24 and NDSR) have similar limitations. However, in assigning NOVA classifications retroactively, most study teams take a conservative approach, assigning the least processed NOVA classifications in cases of ambiguity. Thus, the lack of reliable approach for collecting processing level in diet data likely biases risk estimates in the same direction as NOVA misclassification.

The field has very few randomized controlled trials, thus the review relies primarily on observational studies, which weaken the evidence. Apart from the four controlled-feeding RCTs of UPF versus minimally processed diets, the evidence base is observational. The four RCTs provide proof-of-concept causal support,[142,149–151] but no long-term RCT of UPF versus minimally processed diets exists. For long-term outcomes such as incident T2DM, cardiovascular events, and liver disease a multi-decade RCT is infeasible, and large prospective cohorts with rigorous exposure assessment are the strongest available design.

There is a lack of pediatric research in U.S. cohorts, limiting an evidence review specific to pediatric cohorts. UPF intake is higher in U.S. children than in U.S. adults, but most pediatric evidence in the pool comes from European or Latin American populations where baseline UPF intake is lower than in the U.S. Because other populations have reported links between UPF intake and BMI and/or adiposity measures, one would expect similar findings in a U.S. population exposed to even more UPF. However, future research should report on whether this association consistently exists in U.S. pediatric cohorts and whether it persists into adulthood.

Despite these limitations, the evidence consistently links higher UPF consumption with adverse metabolic outcomes.

Review of Existing Federal, Society, and International Guidelines

To take a thoughtful, unbiased approach to dietary guidelines for Texans, the TNAC reviewed extensive published research and associated conclusions in partnership with numerous subject matter experts, as previously described. Additionally, the TNAC sought input and content submissions from experts across a variety of dietary guidelines nationally and globally. In addition to reviewing the recently released 2025-2030 DGA, this report also summarizes key learnings from selected medical society guidelines and international guidelines. Lessons learned across different systems and approaches helped shape the proposed dietary guidelines for Texans.

Federal Guidelines Overview

The 2025–2030 DGA offer a first-ever emphasis on UPF with the overall message to "eat real food" while reducing UPF. Prior iterations of the DGA placed a primary emphasis on individual nutrients (such as sodium content, added sugar, saturated fat, etc.), with defined eating patterns such as the Mediterranean, the Dietary Approaches to Stop Hypertension (DASH), and Vegetarian. The 2025-2030 DGA focus on dietary quality and whole foods, emphasizing reducing the proportion of the dietary pattern from UPF sources and taking a more aggressive stance to reduce added sugars, especially for children. Americans are encouraged to increase whole-food choices without additives or modified substances, including beverages.

Core recommendations from the 2025–2030 DGA include:

- Eat the Right Amount for You: Stay within your individualized needs, utilizing appropriate portion sizes and choosing nutrient-dense foods
- Prioritize Protein at Every Meal: 1.2-1.6 grams per kilogram per day for adults with an emphasis on high quality protein sources
- Consume Dairy: Enjoy three-servings of dairy daily from a variety of fat options while maintaining <10% of overall dietary intake from saturated fat
- Eat Vegetables and Fruits Throughout the Day: three servings of vegetables and 2 servings of fruit from whole or minimally processed forms with no or little added sugars

- Incorporate Healthy Fats. Minimize Saturated Fat: keep saturated fats <10% of dietary intake
- Focus on Whole Grains: choose two to four servings of unrefined, whole grains
- Limit Highly Processed Food, Added Sugars and Refined Carbohydrates. Eat Real Foods: emphasize fruits, vegetables, nuts and seeds, legumes, whole grains, fish, and minimally processed high quality protein sources such as poultry, fresh meat, and dairy products
- Limit Alcoholic Beverages

Many of the core principles that have guided previous DGA remain unchanged. Consistent with prior recommendations, the guidelines continue to support limits on sodium intake and saturated fat consumption as part of an overall healthy dietary pattern. The report also places renewed emphasis on adequate protein intake across the lifespan, particularly in the context of healthy aging and preservation of muscle mass.

Several recommendations have evolved. The guidelines provide more specific guidance regarding added sugar intake while taking a less prescriptive approach to alcohol consumption than previous editions. In addition, the guidelines place greater emphasis on dietary patterns centered around whole and minimally processed foods, reflecting growing concerns about the role of UPF (which contain additives, modified substances, and typically little to no whole foods) in population health. Collectively, these recommendations reinforce a food-first approach that prioritizes nutrient-dense foods and overall dietary patterns associated with improved long-term health outcomes.

Selected Society Guidelines

American Diabetes Association

The American Diabetes Association (ADA) recently published their 2026 Standards of Care in Diabetes.[288] The statement endorses a food-based, eating pattern-centered approach to nutrition in diabetes, shifting away from a macronutrient-focused framework and toward guidance centered on what people actually eat. It emphasizes that there is no single ideal macronutrient ratio; rather, it recommends healthy patterns of eating, such as the Mediterranean diet, that prioritize non-starchy vegetables, whole fruits, legumes, lean proteins, whole grains, nuts and seeds, and low-fat dairy or nondairy equivalent alternatives, while minimizing red meat, sugar-sweetened beverages, sweets, refined grains, processed and UPF.

Clinically, the ADA recommends referral to a registered dietitian nutritionist for all people with prediabetes or diabetes for MNT.[288] MNT reduces A1c levels by 1.0–1.9% in type 1 diabetes and 0.3–2.0% in T2DM, produces cost savings via improved cardiometabolic outcomes. The ADA recommends insurance coverage of MNT.

The 2026 standards also address food insecurity, directly noting that it affects 16% of adults with diabetes compared with nine percent of adults without diabetes.[288] Food insecurity increases the risk of complications of diabetes, such as hyperglycemia from reliance on inexpensive carbohydrate rich UPF foods, or hypoglycemia from inconsistent carbohydrate intake in those on sulfonylureas or insulin. The ADA recommends screening for food insecurity during clinical encounters with referral to local community resources for positive screens.

At the program level, the ADA endorses Diabetes Self-Management Education and Support, a reimbursable clinical intervention that includes healthy eating as a core content area and is associated with lower A1C, improved quality of life, reduced healthcare costs, and lower all-cause mortality.[288] The ADA also points to structured nutrition trials, including Look AHEAD, DiRECT, PREVIEW, and the recent DASH4D feeding study, as evidence that structured nutrition interventions can produce clinically meaningful improvements in weight, blood pressure, and glycemic control in T2DM. Furthermore, the ADA highlights the role of community health workers, peer educators, and lay leaders in delivering ongoing diabetes self-management support, including nutrition support, which may extend reach in communities facing access barriers.

American Heart Association Dietary Guidance

In 2026, the American Heart Association (AHA) updated dietary guidelines to define a heart-healthy dietary pattern through nine features: balancing energy intake to maintain a healthy weight; eating plenty and a variety of vegetables and fruits; favoring whole grains over refined; choosing healthy proteins with limited lean unprocessed red meat; replacing saturated fats with unsaturated, non-tropical plant oils; choosing minimally processed foods over UPF; minimizing added sugars; reducing sodium; and avoiding or limiting alcohol.[289] The AHA recommends that these dietary patterns be adopted early and maintained throughout life.

To address diet-related chronic disease, the AHA endorses "Food Is Medicine" (FIM) approaches to include providing healthy food to prevent, manage, or treat clinical conditions in coordination with health care.[58] Core interventions include medically tailored meals, medically tailored groceries, and produce prescriptions.[290] A 2025 AHA systematic review of 14 U.S. randomized controlled trials found that FIM consistently

improved dietary quality and food security.[290] However, effects on clinical outcomes such as HbA1c, blood pressure, and hospitalizations were inconsistent, largely due to small sample sizes, short durations, and heterogeneous designs. The AHA therefore calls for larger, well-powered trials with standardized outcomes, behavioral strategies to boost engagement, cost-effectiveness analyses to guide payer coverage, and policy advocacy to enable sustainable financing through Medicare, Medicaid, and commercial insurance, efforts now underway through its Health Care by Food initiative.[58,290]

American Cancer Society

The American Cancer Society (ACS) recommends a dietary pattern and lifestyle approach focused on reducing cancer risk across the lifespan. The ACS Guideline for Diet and Physical Activity for Cancer Prevention emphasizes maintaining a healthy body weight throughout life, engaging in regular physical activity, following a healthy dietary pattern at all ages that emphasizes vegetables, fruits, whole grains, and legumes, and limiting or avoiding red and processed meats, sugar-sweetened beverages, highly processed foods, and alcohol.[15,291] The ACS recognizes that dietary patterns, rather than individual nutrients, are most strongly associated with cancer prevention and recommends creating supportive environments that make healthy choices easier and more accessible. To translate these recommendations into practical action, the ACS provides extensive consumer-facing educational resources, recipes, meal-planning guidance, and healthy eating tools through its "Eat Healthy" initiative, which helps individuals apply cancer prevention principles in everyday food choices.[292]

For cancer survivors, the ACS recommends broadly following the same healthy dietary and physical activity patterns advised for cancer prevention, while tailoring recommendations to individual treatment history, symptoms, comorbidities, nutritional status, and survivorship goals. The ACS Survivorship Guideline emphasizes maintaining a healthy weight when possible, engaging in regular physical activity, consuming a diet rich in vegetables, fruits, whole grains, and plant-based foods, and limiting processed and red meats, alcohol, and UPF.[293,294] These recommendations are intended to support overall health, quality of life, management of treatment-related side effects, and reduction of chronic disease risk among the growing population of cancer survivors. The guideline also highlights the importance of individualized nutrition care, multidisciplinary support, and addressing social and environmental barriers that may affect a survivor's ability to maintain healthy dietary behaviors.

American College of Lifestyle Medicine Dietary Position

The American College of Lifestyle Medicine's (ACLM) dietary position statement emphasizes Food as Medicine (FAM) principles and recommends dietary patterns centered on a variety of whole and minimally processed plant foods, including

vegetables, fruits, whole grains, legumes, nuts, seeds, and mushrooms, while minimizing ultra-processed food, red and processed meats, foods high in saturated fat, refined carbohydrates, added sugars, and excess sodium.[295]

ACLM highlights that dietary interventions exist along a continuum ranging from health promotion and disease prevention to treatment and potential remission of chronic disease. The organization also emphasizes the importance of culturally tailored, person-centered care delivered through interprofessional healthcare teams, including physicians and registered dietitian nutritionists trained in lifestyle medicine competencies. ACLM's position statement and related educational resources highlight growing evidence linking ultra-processed food intake with adverse cardiometabolic and other health outcomes while supporting practical implementation strategies such as culinary medicine education and shared medical appointments.

The following table summarizes dietary recommendations, implementation strategies, and policy approaches identified across major professional organizations. While substantial agreement exists regarding healthy dietary patterns, differences emerge in how these recommendations are implemented, communicated, and supported.

Table 3. Organizations' dietary recommendations and implementation strategies

Organization	Core dietary pattern described	Key foods encouraged	Key foods/ behaviors limited	Supporting behaviors encouraged	Implementation strategies
American Diabetes Association	1) Food-based, eating-pattern approach 2) No single ideal macronutrient ratio 3) Emphasizes individualized nutrition planning and Mediterranean-style dietary patterns	Non-starchy vegetables, whole fruits, legumes, lean proteins, whole grains, nuts, seeds, low-fat dairy or nondairy alternatives	Sugar-sweetened beverages, sweets, refined grains, red meat, processed foods, ultra-processed food.	Ongoing diabetes self-management, addressing food insecurity, and individualized care planning	1) Medical Nutrition Therapy by registered dietitian nutritionists 2) Diabetes self-management education 3) Food insecurity screening 4) Referral to community resources 5) Engaging community health workers, peer educators, and lay leaders for ongoing support
American Heart Association	Lifelong heart-healthy dietary pattern focused on cardiometabolic health	Vegetables, fruits, whole grains, healthy protein sources, and	Added sugars, excess sodium, saturated fats, UPF, and alcohol	Weight management and long-term adherence to healthy dietary patterns	1) Food Is Medicine approaches, including produce prescriptions, medically tailored

		unsaturated plant oils			groceries, and medically tailored meals 2) Call for larger implementation studies on standardized outcomes and behavioral engagement strategies 3) Economic research on sustainable financing mechanisms through healthcare systems and insurers
American Cancer Society	Dietary patterns and lifestyle approaches focused on cancer prevention and survivorship	Vegetables, fruits, whole grains, legumes, plant-based foods	Red and processed meats, SSBs, highly processed foods, and alcohol	Regular physical activity Healthy weight maintenance Survivorship-focused lifestyle management	1) Consumer education resources, recipes 2) Meal-planning tools and survivorship nutrition guidance 3) Individualized nutrition planning 4) Multidisciplinary support and attention to socio-environmental influences on healthy eating
American College of Lifestyle Medicine	Food-as-Medicine approach emphasizing whole, minimally processed, plant-forward dietary patterns	Vegetables, fruits, legumes, whole grains, nuts, seeds, mushrooms	UPF, red and processed meats, refined carbohydrates, added sugars, foods high in saturated fat, and excess sodium	Chronic disease prevention and remission through lifestyle modification	1) Culinary medicine programs 2) Shared medical appointments 3) Interprofessional care teams 4) Culturally tailored interventions 5) Personalized care and lifestyle medicine education

Selected International Guidelines

Over 100 countries worldwide have developed dietary guidelines to guide public health initiatives, nutrition education, and agricultural policies.[296] Guidelines are based on scientific evidence and customized according to local food availability, cultural preferences, and government priorities. Lessons learned from other countries can help inform local implementation of nutrition guidelines.

Brazil – Chile – Canada Perspectives: Dietary Guideline Emphasis on Minimally Processed Foods

Brazil

The Brazilian Dietary Guidelines (BDG) released in November 2014 represented a departure from conventional guidelines, which historically had focused primarily on the nutrient content of foods. The 2014 BDG instead focused on the level of processing, based on the NOVA classification system.[98] The recommendations included making unprocessed or minimally processed foods (NOVA group 1) the foundation of one's diet and avoiding UPF (NOVA group 4).[297] In addition, the BDG recognized barriers to healthy eating, including food costs, lack of culinary skills, lack of time for food preparation, and food marketing, and provided suggestions to overcome these barriers.[297]

The 2014 BDG were successful in raising awareness in Brazil and around the world of the health risks associated with UPF consumption, as evidenced by a steady increase in mentions of UPF in Brazilian media and in the scientific literature.[298] Although they provided the foundation for many policy measures to improve nutrition in Brazil, including bans on UPF in school cafeterias and Ministry of Health institutional settings, as of 2018 UPF consumption as a percentage of total energy intake was still increasing, particularly among Black and indigenous people, rural communities, and households in the lowest three quintiles of income.[299]

Chile

The release of the 2014 Brazilian Dietary Guidelines inspired other Latin American countries, including Chile, to make similar updates to their food guides.[298] Accordingly, the most recent Dietary Guidelines for Chile, published in 2022, emphasize intake of unprocessed and minimally processed foods and avoiding UPF.[296] Chile has supported the implementation of these recommendations since 2016 through the Food Labeling and Advertising Law, a comprehensive set of policies to reduce intake of foods and beverages high in calories, sugar, sodium, and saturated fat through mandatory front-of-package warning labels, restrictions on child-targeted advertisements, and bans on selling in schools.[300,301] An evaluation found significant reductions in purchases of overall calories, sugar, sodium, and saturated fat after the first phase of implementation of the law.[301] Another study looking specifically at the effect of marketing restrictions found that children's exposure to ads for targeted foods decreased by 57% after phase 1 (content restrictions) and by 73% after phase 2 (time restrictions), compared to the pre-regulation baseline.[300]

Canada

The latest update to Canada's Food Guide (CFG), published in 2019, was also inspired by the Brazilian Dietary Guidelines, and it represented a significant departure from previous versions.[298] Instead of providing specific numbers of food servings, the 2019 version included more general recommendations to eat more whole and minimally processed foods, choose plant-based proteins more often, and limit UPF.[302] Notably, the guidelines included a plate graphic to help put the recommendations into practice at each meal, with half the plate being made up of vegetables and fruits, one quarter protein foods, and one quarter whole grains.[303] Another notable feature of the 2019 CFG was the explicit lack of industry involvement, with a commitment from government to keep the recommendations grounded in science and free from conflict of interest.[304]

Several studies have assessed the potential health impacts of CFG, with mixed findings. One prospective analysis of data from the UK Biobank cohort found that participants with the highest adherence to CFG recommendations had a 24% reduced risk of cardiovascular disease.[302] However, other studies have found that higher adherence to CFG may be associated with inadequate nutrient intake, particularly calcium and vitamin D in children[305] and older adults,[306] although researchers involved in these studies had received funding from the dairy industry.

France – UK – Italy Perspectives: Labeling Systems Embedded within Broader National Dietary Philosophies

Since the early 2000s, several European countries have implemented front-of-pack nutrition labeling systems to improve consumer understanding, encourage healthier purchasing behaviors, and support national public health goals.[307] These systems, based on different formats, are embedded within broader cultural, political, and agricultural contexts, which shape both their implementation and public reception.

France

France implemented the Nutri-Score system in 2017[308] as part of the broader Programme National Nutrition Sante/National Nutrition and Health Program (PNNS).[309] Nutri-Score is a color-coded front-of-pack labeling system ranging from A to E designed to provide rapid and simplified nutritional interpretation for consumers. It aligns with the national public health campaign "Manger Bouger" ("Eat and Move"), which promotes healthier lifestyles and prevention of chronic diseases. The French approach is rooted in a population-level public health philosophy aimed at reducing the consumption of foods high in sugar, salt, and saturated fats, while encouraging fruits, vegetables, legumes, and fiber-rich foods. Nutri-Score has since gained support across

several European countries and reflects an effort to simplify nutritional information and improve accessibility for consumers.[310] However, the system has generated debates linked to France's strong agricultural and culinary traditions. Certain traditional "terroir" products, despite their cultural and historical value, may receive unfavorable scores, leading some stakeholders to view the labeling system as a challenge to national food heritage and established food norms.[311] Nevertheless, in, 2025, the National Assembly in Paris voted to introduce mandatory Nutri-Score labeling on all pre-packaged foods, while granting exemptions for certain certified products such as protected designation of origin, protected geographical indication,, and organic foods. This decision marked a major step toward greater nutritional transparency and public health promotion.[312]

United Kingdom

In 2013, the United Kingdom adopted a front-of-pack "traffic light" labeling system based on red, amber, and green indicators for nutrients such as fat, sugar, and salt, following earlier initiatives led by the Food Standards Agency in the mid-2000s.[313] This system is integrated into broader public health recommendations, including the National Health Service (NHS) healthy eating guidance and the Eatwell Guide.[314] The British model emphasizes consumer education, transparency, and behavioral communication. Rather than providing a single global score, the traffic light system offers nutrient-by-nutrient information that allows consumers to compare products quickly and make informed decisions. The approach relies heavily on visual communication and personal responsibility in dietary choices. This system has become widely recognized by consumers and illustrates how intuitive labeling strategies may influence purchasing behaviors while maintaining a relatively analytical presentation of nutritional content.[315]

Italy

In 2020, Italy developed the NutrInform Battery system partly in response to the expansion of Nutri-Score across Europe.[316] Italian dietary recommendations are strongly rooted in the Mediterranean Diet tradition, where shared meals, culinary rituals, and traditional products occupy an important cultural role. Unlike simplified ranking systems, NutrInform focuses on portion-based nutritional information and consumer education rather than assigning products an overall positive or negative score. Its "battery" symbols indicate the percentage of energy, fats, saturated fats, sugars, and salt contained in a single portion relative to recommended daily intake. This system reflects concerns that simplified labeling models may reduce the complexity of dietary practices and unfairly penalize traditional foods associated with Italian food culture.[317] Italy's position illustrates how nutrition policy may become

closely intertwined with questions of cultural identity, agricultural sovereignty, and protection of national food heritage.[318] The debate surrounding front-of-pack labeling therefore extends beyond nutritional science alone and touches broader political and cultural dimensions.[319]

Conclusion

European experiences demonstrate how nutrition labeling systems interact with broader dietary guidelines, consumer education strategies, agricultural interests, and culturally rooted food practices across diverse populations. Transparency, simplicity, and consumer accessibility remain important goals across contexts, but public trust and cultural acceptability are equally critical for successful implementation. France, the United Kingdom, and Italy's approaches suggest that no single labeling model universally fits all countries and that nutrition policies are often embedded within broader national dietary philosophies and social values.[320] For instance, even among countries that adopted Nutri-Score (France, Germany, Belgium, Luxemburg, Netherlands, Portugal and Switzerland), national dietary philosophies and implementation rationales remain distinct, illustrating that front-of-pack labeling systems are interpreted through local cultural, political, and public health frameworks.[321]

While the recommendations of the previously reviewed professional organizations were largely consistent on recommended dietary patterns and long-term health goals, organizations varied in their approaches. To further explore how dietary guidance has been translated into practice at the population level, Table 4 examines nutrition policies (e.g. food labeling policies), education efforts, and environmental supports adopted across the countries reviewed in this report.

Table 4. International dietary guideline strategies and transferable insights for Texas

Country	Emphasis areas	Policy tools used	Transferable insights to inform Texas discussion
Brazil	Shift dietary guidance away from nutrients alone and toward food processing; promote unprocessed and minimally processed foods while reducing UPF	1) Dietary guidelines based on NOVA food processing classification system 2) National messaging encouraging minimally processed foods as the foundation of the diet 3) Restrictions on UPF in school cafeterias and Ministry of Health institutional settings 4) Public education around food preparation, cooking skills, and meal practices	1) Consider incorporating food processing level into dietary guidance rather than focusing exclusively on nutrients 2) Explore nutrition standards for schools and public institutions that prioritize minimally processed foods 3) Emphasize food literacy, cooking skills, and meal preparation as part of nutrition promotion
Chile	Reduce consumption of foods and beverages high in calories, added sugars, sodium, and saturated fat through population-level policy interventions	1) Mandatory front-of-package warning labels 2) Food Labeling and Advertising Law 3) Restrictions on child-targeted food advertisements 4) Marketing restrictions for unhealthy foods 5) Bans on sales of targeted products in schools	1) Evaluate the potential role of simplified front-of-package nutrition communication tools 2) Consider approaches to reduce children's exposure to unhealthy food marketing 3) Explore school nutrition policies that support healthier food environments
Canada	Promote whole and minimally processed foods with simple visual guidance and practical meal-planning tools	1) Canada Food Guide plate model (½ vegetables/fruits, ¼ protein foods, ¼ whole grains) 2) National consumer-facing educational materials 3) Strong emphasis on plant-forward eating patterns 4) Development process designed to minimize industry influence	1) Develop highly visual, consumer-friendly educational tools that simplify dietary guidance 2) Emphasize practical meal construction rather than nutrient counting 3) Promote healthy eating patterns through straightforward messaging that can be adapted across cultures and communities

Country	Emphasis areas	Policy tools used	Transferable insights to inform Texas discussion
France	Improve dietary quality through consumer education, simplified nutrition labeling, and chronic disease prevention campaigns	1) Nutri-Score front-of-package labeling system (A-E scale) 2) National "Manger Bouger" ("Eat and Move") campaign promoting healthy lifestyle 3) Integration of nutrition and physical activity messaging 4) Tax incentives and support mechanisms for selected agricultural and food products, including some quality-certified and organic products	1) Pair nutrition guidance with physical activity messaging rather than treating them separately 2) Consider simplified consumer-facing nutrition communication systems 3) Explore policy approaches that align agricultural incentives with public health goals
United Kingdom	Increase consumer transparency and support healthier purchasing decisions through nutrition labeling and public education	1) Traffic-light labeling system for fat, sugar, and salt 2) National Eatwell Guide 3) Public education campaigns focused on food choices 4) Behavioral communication approaches designed to simplify decision-making	1) Consider communication tools that help consumers quickly interpret nutrition information 2) Use behavioral science principles to make healthier choices easier to identify 3) Develop practical dietary guidance that can be understood across literacy levels
Italy	Preserve traditional dietary patterns while promoting nutrition education and informed consumer choice	1) NutrInform Battery front-of-package labeling system 2) Promotion of Mediterranean dietary traditions 3) Protection of traditional food systems and regional agricultural products 4) Integration of cultural food heritage into nutrition messaging	1) Recognize that healthy dietary guidance can be culturally tailored while remaining evidence-based 2) Leverage traditional Texas foodways and regional food cultures when communicating dietary recommendations 3) Emphasize healthy preparation methods and balanced dietary patterns rather than eliminating culturally important foods

Cross-country themes

Several themes emerged consistently across international dietary guidelines. Main cross-country themes include:

- Increased consumption of whole and minimally processed foods.
- Reduced consumption of UPF.

- Simplified nutrition communication through visual tools or front-of-package labeling.
- Public education campaigns that extend beyond clinical settings.
- Recognition that policy environments influence dietary behavior.
- Integration of nutrition guidance with broader social, cultural, educational, and environmental contexts.
- Movement away from isolated nutrient-focused recommendations toward dietary patterns and food quality.

Dietary Guidelines for Texans

Key Concepts

Foods without a lot of processing are best for your body.

These guidelines include examples of healthy foods. Many foods not listed here in these food groups may also be great choices.

Foods in their original form, like they are found in nature, form the basis for health.

Eating well means eating healthy food most of the time, food from each group, and enough to meet your needs.

- Fill half your plate with vegetables and fruit at every meal for better digestion and health.
  - Choose a variety of colors such as red/pink (beets, radish, tomatoes, strawberries, apples, grapefruit, red peppers); orange/yellow (carrots, squash, pumpkin, sweet potato, peaches, cantaloupe); green (spinach, asparagus, broccoli, okra, cucumbers, pears); blue/purple (cabbage, berries, plums); white (cauliflower, potatoes, onion).
- Eat three or more servings of healthy proteins each day to keep your muscles, brain, bones, and skin strong.
  - Healthy proteins are unprocessed or minimally processed. This means they are close to how they are in nature—avoiding added ingredients, such as preservatives.
  - Beans, peas, lentils, seafood, poultry, beef, pork, lamb, wild game, eggs, nuts, and seeds are all good ways to get protein.

- Include healthy fats every day.
  - Some sources of healthy fats include nuts, seeds, fatty fish, olive oil, and avocadoes.
- Eat food for healthy bones and teeth every day.
  - Foods that help keep bones healthy include those with protein, calcium, vitamin D, vitamin K, and magnesium.
  - Foods that have these nutrients include:
    - Unflavored dairy foods with no sugar added: whole fat or low-fat milk, kefir, yogurt, and cheese.
    - Non-dairy foods: fatty fish with bones like jarred/canned salmon or sardines, tofu, fortified soy or other plant-based milk, okra, green cabbage, broccoli and leafy greens (kale, mustard greens, collards, bok choy, turnip, dandelion), beans (black-eyed peas, soy, white, navy, great northern, garbanzo), seeds (sesame, chia, flax, poppy, hemp), nuts (almonds, Brazil, hazelnut).
- When you choose grains, choose whole grains.
  - Whole grains are unprocessed or minimally processed. That means they are close to how they are in nature. They do not have lots of added ingredients like preservatives.
  - Whole grains include brown rice, corn, barley, buckwheat, millet, quinoa, whole oats, whole wheat, farro, and others.
- Drink water when you are thirsty.
  - If you drink tea or coffee, consider reducing or avoiding sugar or sugar substitutes or artificial creamers.
  - There is no safe amount of alcohol. Consider reducing or avoiding alcohol.

How you prepare your food matters.

- Make your own food to save money and have more control over what is in your food.
- Prepare food simply using spices and herbs to make food taste great and help prevent disease. Limit excess sugar, fat, and salt.
- Bake, broil, roast, poach, lightly sauté, stir-fry, or steam your food to keep the nutrients in them.

- Smoking, frying, and grilling can create substances in your food that can be harmful to your health. Use these cooking methods less often.
- When buying food in packages, jars, cans, or boxes, look for ones without many added ingredients.
  - Frozen, jarred, or canned produce without added coloring, preservatives, salt and sugar are good choices.
  - UPF are foods made in a factory that are less healthy. They may have excess fat, sugar, salt, and ingredients like artificial colors, flavors, and sweeteners. Choose these less often.
- Avoid heating food in its packaging (plastic).

There are many ways to eat healthy.

- Many patterns of eating can be healthy. Find healthy foods that fit your culture, budget, and likes.
- Traditional diets, with foods like seafood, vegetables, fruits, whole grains, and healthy fats help maintain health and prevent chronic disease.
- Eating mostly minimally processed plant foods is another way to stay healthy.
- Foods from animals like unprocessed or minimally processed meat and dairy can be part of a healthy diet. Balance them with plenty of high fiber foods like vegetables and fruits.

Dietary Guidelines Visual

Figure 1. Eat Real Food, Y'all

This visual developed by the TNAC was informed by a review of the scientific evidence, existing national and international dietary guidance patterns, and emerging scientific literature on dietary quality, chronic disease prevention, and metabolic health.

The image is intentionally designed to represent a wide variety of foods and dietary traditions commonly enjoyed across Texas communities, including foods rooted in diverse food cultures. It is not intended to represent every food or dietary pattern, but rather to illustrate how many different whole and minimally processed foods can fit within a balanced dietary pattern.

The visual is intended to be consistent with the 2025-2030 Dietary Guidelines for Americans (DGA) graphic, including the same food groups to avoid confusion. This visual separates protein, dairy, and healthy fat into three distinct groups: healthy proteins, dairy, and healthy fats to note the differences in the types of foods in each

group. The food groups are placed in a similar location as they are placed on the DGA graphic.

Each food group emphasizes whole foods, including both animal and plant foods grown, caught, and raised in Texas. The healthy proteins group includes seafood, beans, black-eyed peas, chicken, eggs, and beef. The dairy group includes milk and plain yogurt. The healthy fats group includes pecans, peanuts, oil, and avocado. The vegetables and fruits group includes a variety of brightly colored plants including green, red/pink, white, orange/yellow, and purple/blue foods. The whole grains group includes unprocessed foods such as brown rice and oats, as well as products made from minimally produced grains such as corn tortillas and whole grain bread. Water is shown as the primary fluid source for Texans.

The Texas-shaped plate is intentionally not filled completely. This reflects the concepts of balance, moderation, and mindful eating, including observations from longevity research suggesting potential benefits associated with avoiding overconsumption and eating until comfortably satisfied rather than overly full.

The TNAC recognizes that the evidence review process is ongoing and iterative. This visual illustrates core Texas dietary guidance principles and communicates healthy

eating patterns in a way that feels culturally relevant, practical, flexible, and uniquely Texan.

From Guidelines to Real Life: A Texas Framework for Eating Well

Science helps us understand what patterns of eating best support health. From decades of research, we can identify dietary patterns that lower risk of chronic disease. These include dietary patterns including vegetables, fruits, whole grains, legumes, nuts and seeds, herbs and spices, healthy fats and proteins, and an approach including balance, variety, and enjoyment.

Science is often generated under controlled or ideal conditions, but real life is not a controlled environment. Texans make food choices within the context of their daily lives, which are shaped by time, resources, culture, family needs, and health conditions. These factors influence not only what people eat, but how, when, and why they eat.

For this reason, dietary guidelines should not be interpreted as a single rigid prescription. Instead, they serve as a starting point. They are a set of evidence-based inputs that must be adapted to real-world circumstances. To support this, we introduce a practical framework that reflects how Texans can translate nutrition guidance into daily life.

Every individual and family experience a unique set of influences that "filter" dietary guidance into realistic, achievable patterns of eating. These filters do not represent barriers alone but include context and preferences. Within each context live meaningful, health-supporting choices.

As Texans, we value independence, practicality, and diverse ways of living. In that spirit, there is not one right way to "eat well." This framework embraces that reality: many pathways toward one shared goal of helping Texans nourish themselves in ways that are feasible, meaningful, and supportive of long-term health.

We encourage nutrition educators to contextualize dietary guidance by approaching conversations with curiosity, understanding unique circumstances (aided by the Five Filters outlined below), and shared decisions rooted in individualized life and health goals.

Food choices don't happen in a vacuum. They're shaped by the social, economic, and environmental conditions in which people live, and while individuals navigate those realities every day, communities, organizations, healthcare systems, schools, employers and policymakers share responsibility for building environments where healthy eating is possible.

From Guidelines to Plates: The Five Filters

1. **Access:** food availability and affordability, impacted by geography, transportation, housing, finances, and circumstances.
2. **Time:** work and school schedules, caregiving responsibilities, and multiple demands on time.
3. **Skills:** cooking confidence and equipment, food storage and strategy, meal planning, and minimizing waste.
4. **Meaning:** food relationship, culture, family practices, preferences, religious beliefs, celebrations, enjoyment, and the social role of food.
5. **Needs:** medical conditions impacting food (including allergies and medications), life stage (growth, pregnancy, aging), and physical activity.

Translating Dietary Guidance into Real-Life Practice

While the Five Filters framework highlights the factors that influence food decisions, implementation requires an additional layer of translation that considers the questions, challenges, and priorities of specific populations. An additional resource in the **Texas Dietary Guidelines Framework Case Examples and Strategies Appendix C** provides a practical framework for adapting evidence-based dietary guidance across diverse Texas communities, life stages, health conditions, and household structures. Organized around common challenges, information needs, relevant nutrition guidance, and communication strategies, these examples illustrate how shared dietary principles can be made more meaningful, actionable, and culturally responsive without altering the underlying scientific recommendations. This resource is intended to support educators, healthcare professionals, community organizations, and policymakers as they translate nutrition guidance into real-world settings across Texas.

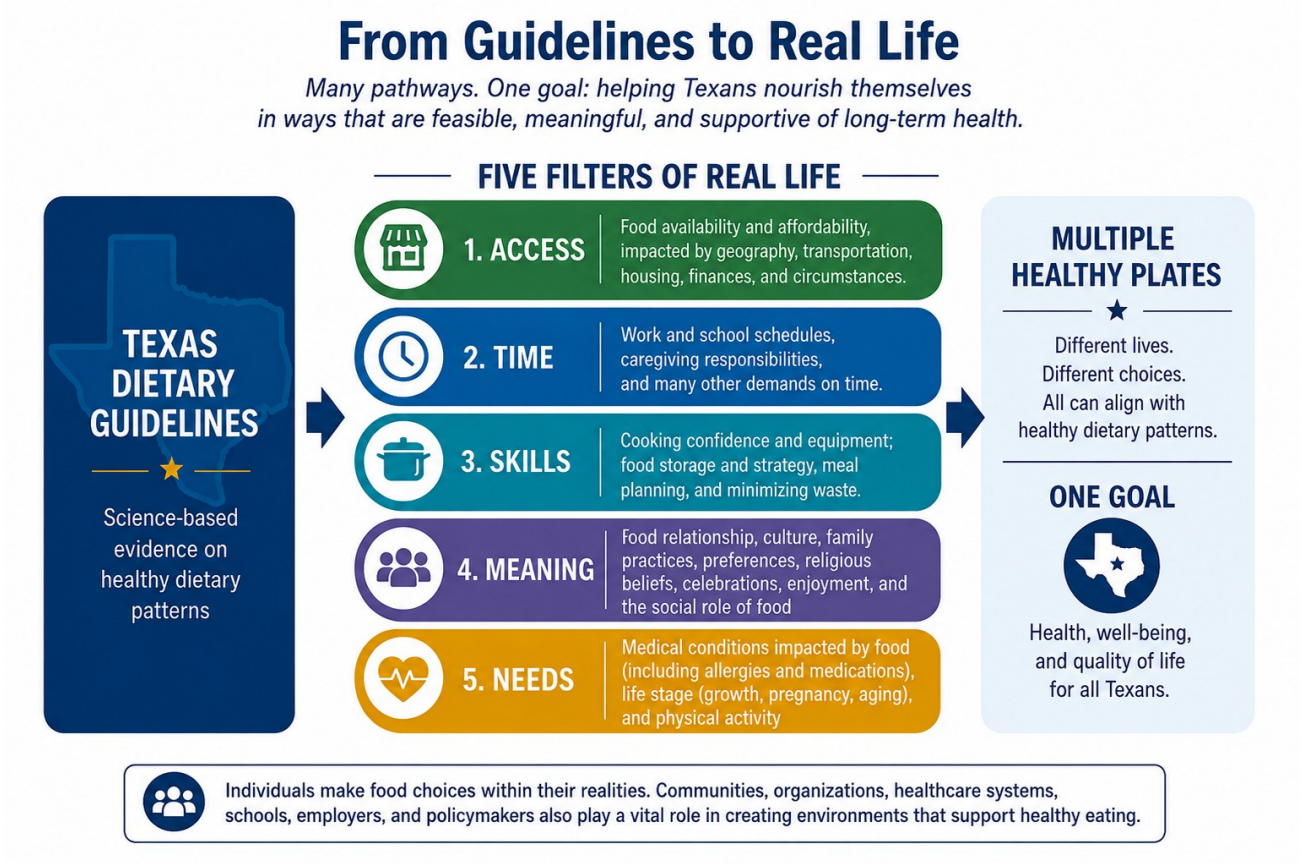


Figure 2. From Guidelines to Real Life illustrates the five filters through which Texans can filter the dietary guidelines based on their access, time, skills, meaning, and needs related to food, as described in more detail above. This results in many pathways to healthier plates. Content developed by Jaclyn Albin with graphic design support from ChatGPT.

Applying the Filter Framework: Case Examples

In the **Texas Dietary Guidelines Framework Case Examples and Strategies Appendix C,** there is a detailed list of examples of Texan dietary strategies through the real-life filters with suggestions for breakfast, lunch, and dinner. We list two of these examples below but have designed 12 detailed scenarios that may help guide the application of the guidelines in practical ways that reflect many types of Texas families.

Busy Family of 4

Limited time, moderate cooking skills, reasonable access to food

Lunch or Dinner: Sheet Pan Meals

One pan, one oven, and minimal cleanup. Arrange protein and vegetables on a sheet pan, roast at 400–425°F for 20–30 minutes while helping with homework.

Easy combinations to rotate: (Mix and match proteins and vegetables per your likes and needs)

Chicken pieces + broccoli florets + sweet potato cubes + olive oil

Salmon fillets + asparagus + cherry tomatoes + slice of avocado

Steaks + bell peppers + zucchini + onion + slivered almonds

May pair with a simple whole grain: Brown rice, quinoa, millet, or barley

Time savers: Wash and chop vegetables early in the week or on weekends and store in daily/meal portions so weeknight sheet pans come together in under 10 minutes of hands-on time. Can batch cook grains early in the week to round out the plate without adding active cooking time.

Key message: Healthy eating doesn't require complicated recipes or lots of time. A sheet pan, whole food ingredients, and basic seasoning (olive oil, salt, garlic powder) can produce a nourishing, satisfying dinner that a family of four can repeat week after week. Convenience and quality can live together.

Breakfast:

Sheet pan eggs — crack a dozen eggs into a sheet pan (grease with olive or avocado oil first) with diced vegetables (optional: add sprinkled cheese); bake at 375°F for 15 minutes, slice into squares and refrigerate.

Overnight oats, buckwheat, or chia pudding in mason jars with milk or yogurt of choice (dairy, soy, almond, coconut, pea), nuts, and berries (assemble Sunday night, grab all week)

Hard boiled eggs (cooked in bulk) + fresh fruit + leftover sheet pan vegetables

Key message: Breakfast for a family doesn't have to happen in real time every morning. One session can stock the refrigerator with ready-to-grab whole food options that make mornings simpler.

Single Adult

Limited transportation, tight budget, limited cooking skills due to experience or mobility issues.

Lunch and Dinner: One-Pan Stovetop Meals

Easy combinations to rotate:

Canned or jarred black beans (rinsed and drained) + frozen corn + salsa + eggs

Frozen stir-fry vegetables + chicken + soy sauce over instant brown rice

Lentil soup from dried lentils (low-cost, no soaking required, 25 minutes) + diced carrots and onions

Pantry anchors: Canned or jarred beans, dried lentils, frozen vegetables, eggs, olive oil, garlic. These are affordable, nutrient-dense, and shelf-stable.

Batch prep idea: Cook a large pot of lentils or beans on Sunday. Use throughout the week for different meals.

Key message: Eating well on a budget is possible with a short list of whole food staples. Canned and frozen options have similar nutrients to fresh and reduce cost and prep time.

Breakfast: Simple Whole Food Anchors

Oatmeal, chia pudding, rice, quinoa, or buckwheat, topped with peanut butter and banana. Stir in yogurt or milk to increase protein intake.

Eggs scrambled with whatever vegetables are on hand (even the wilting ones) + fruit or whole grain or corn tortillas.

Protein smoothie – one to two cups dairy or plant-based milk, one to two scoops dried milk or protein powder, one cup blueberries, 1-½ banana.

Greek yogurt + frozen fruit (thawed overnight) + low sugar granola.

Nut or seed butter + sliced apple or other fruit or vegetable.

Batch prep idea: A large container of overnight oats lasts four to five days in the refrigerator. Total cost per serving: under $1.

Key message: Breakfast doesn't require a recipe. A few reliable combinations built from affordable whole food staples are enough to fuel a full morning of class, work, or chores.

Life Stage Guidance and Practical Considerations

Across every life stage, Texans benefit from food patterns built on whole or minimally processed foods: vegetables, fruits, high-quality proteins, healthy fats, beans, lentils, nuts, seeds, dairy or fortified alternatives, and intact or minimally processed whole grains. Water should be the default beverage. Added sugars, sugar-sweetened beverages, highly processed snack foods, artificial colors, and refined grain products should be limited, especially for children.

UPFs are factory-made products that often contain refined starches, added sugars, excess sodium, fat, flavorings, colors, emulsifiers, preservatives, and other additives, with little intact whole food. Examples include many packaged snack foods, sweetened cereals, candy, soda, sweetened drinks, fast foods, processed desserts, and many packaged meals.

Not all packaged foods are unhealthy. Frozen vegetables, plain yogurt, canned or jarred beans, canned or jarred fish, nut butters, and other simple packaged foods can support healthy eating when they have little or no added sugar and reasonable sodium.

Babies (0-12 months)

What to Feed

- Babies zero to six months: breastmilk or formula:
  - Breast milk is the best source of nutrition for most babies.
  - Breast milk is associated with better health and lower risk of some infections and illnesses. If you are able, solely breastfeed or offer breastmilk to your baby for the first 6 months.
  - Iron-fortified infant formula is a complete source of nutrition for your baby if you do not breastfeed.
- Babies six to12 months: breastmilk or formula (main source of nutrition) plus solid foods:
  - At about six months of age, infants can start to have other foods.
  - Starting with iron-rich foods like meat purees or iron-fortified infant cereals helps your baby get enough iron.
  - Pureed or soft vegetables and fruits can also be offered.

- Once your baby can hold food, you can offer long chunks of soft fruits and vegetables and let them see what they can eat.
- Avoid giving hard or chewy foods like candy, hot dogs, popcorn, apple pieces, nut butter, and bacon to babies and young children.

Feeding Tips:

- Avoid food and drinks with added sugar or salt.
- Avoid fruit juice, honey, and cow's milk for the first 12 months.

Young Children (ages 1-5)

What to Feed:

- Feed your young child three balanced meals a day and one to two snacks.
- Feed your young child vegetables, fruits, whole grains, and high-quality proteins.
- Include foods for bone health often.
  - Foods that support bone health include protein-rich foods, calcium-rich foods, vitamin D sources, magnesium-rich foods, vitamin K-rich vegetables, and vitamin C-rich fruits and vegetables.
  - Examples include plain yogurt, kefir, milk, cheese, calcium-fortified unsweetened plant milks, calcium-set tofu, sardines or salmon with bones, eggs, fish, poultry, meat, beans, lentils, nuts, seeds, leafy greens, broccoli, berries, citrus, and other whole foods.
- Young children do not need added salt and sugar. Sugar can lead to cavities or other health problems. Offer healthy food most of the time.

Feeding Tips

- Eat together as a family whenever you can.
- Encourage curiosity about new foods by talking about the colors, smells, and feel of new foods instead of likes/dislikes.
- Offer regular meals and snacks and provide healthy foods.
  - Offer food without comment. Let children decide how much and what to eat from their plate without pressure or praise.

- If your child does not like mixed foods, you can offer the parts of meals separately. For example, instead of a taco, you could offer the tortilla and each filling part separately.

School-Aged Children (ages six to12)

What to Eat:

- Offer your child healthy foods like whole vegetables, fruits, whole grains, eggs, meat poultry, and beans.
- Offer foods that provide nourishing fats, such as avocado, eggs, salmon, sardines, plain yogurt, cheese, olive oil, nut and seed butters in safe forms, and ground nuts or seeds. These foods support growth, brain development, hormone production, and absorption of vitamins A, D, E, and K.
- Include foods that support bone health like protein-rich foods, calcium-rich foods, vitamin D sources, magnesium-rich foods, vitamin K-rich vegetables, and vitamin C-rich fruits and vegetables.
  - Examples include plain yogurt, kefir, milk, cheese, calcium-fortified unsweetened plant milks, calcium-set tofu, sardines or salmon with bones, eggs, fish, poultry, meat, beans, lentils, nuts, seeds, leafy greens, broccoli, berries, citrus, and other whole foods.
- School-aged children often ask for the food their friends eat or that they see in ads. Talk about how different families eat different ways. Talk about why your family eats healthy foods most of the time.

Tips:

- Children who cook and shop with their families can learn math, reading, and cooking skills.
- Eat together as a family as much as you can.
- Keep mealtimes positive.

Teens (ages 13-18)

What to Eat:

- Teens' needs for nutrients increase as they grow.
- Offer your teen healthy foods like whole vegetables, fruits, whole grains, healthy proteins, and foods for bone health.

Tips:

- Invite teens to shop and cook with you side-by-side. This sets them up for success later. Let them pick a recipe, take charge of a meal, or lead a grocery trip. These moments build real-life skills for adulthood.

Adults

What to Eat:

- Eating a variety of healthy foods during young adulthood helps prevent diseases like diabetes, heart disease, cancer, and more.
- Early in adulthood, until age 25, adults are still increasing their bone mass. Eat food rich in protein, calcium, vitamin D, magnesium, and vitamin K is important during this time.

Pregnancy

What to Eat:

- During pregnancy, your need for iron, folate, and other nutrients increases.
- Eat a variety of foods in pregnancy, including foods rich in iron like meat, poultry, fish, beans, fruit, and foods rich in folate such as leafy greens, nuts, beans, peas, and grains.

Tips:

- Talk to your health care professional about taking a daily prenatal vitamin during pregnancy.
- Food safety is even more important during pregnancy. You and your baby are at higher risk for food borne illness during pregnancy. To stay safe, keep hot foods hot and cold foods cold.
- Fish can be an important source of protein, iodine, selenium, and omega-3 fats. Choose lower-mercury fish and check Texas fish consumption advisories for locally caught fish. Choose low mercury fish, like salmon, snapper, and sardines.

Breastfeeding/Lactation

What to Eat:

- When you are breastfeeding, you have higher energy, protein, and other nutrient needs.

- Focus on minimally processed nutrient dense foods and drink plenty of water.
- Many women may need supplements of minerals or vitamins while breastfeeding. Talk to your healthcare provider for recommendations.
- Breast milk contains B12, but the amount depends on maternal B12 status. Exclusively breastfed infants of mothers who consume no animal products can become deficient if maternal B12 is low.

Older Adults

What to Eat:

- As you age, you may need fewer calories. Eating a nutrient rich diet but in smaller portions is important.
- Eating vegetables and fruits, especially leafy greens and berries, seafood, beans, peas, nuts, seeds, and olive oil can help keep aging brains healthy.
- Fiber is found in whole plant foods such as vegetables, fruits, beans, peas, lentils, nuts, seeds, and intact or minimally processed whole grains. Eating fiber-rich foods regularly supports digestion, heart health, blood sugar balance, and healthy aging.
- Include foods for bone health like dairy, tofu, leafy greens, beans, fatty fish with bones, and nuts and seeds.
- Vitamin B12 is found naturally in animal foods such as seafood, meat, poultry, eggs, milk, yogurt, and cheese. Fortified foods such as nutritional yeast and unsweetened fortified plant milks can provide B12 for people who eat little or no animal foods.
    - Older adults, people with digestive or absorption problems, people taking metformin or acid-blocking medications, pregnant or breastfeeding people on vegetarian or vegan diets, and infants of vegan mothers may need B12 supplements.
- Include protein-rich foods at each meal to help maintain muscle, strength, immune function, and independence.

Education Recommendations

Education is a foundational strategy for improving nutrition and metabolic health across the lifespan. Effective nutrition education should extend beyond knowledge acquisition to support practical decision-making, food and culinary skills, behavior change, and navigation of available resources. Educational efforts are most effective when they are individualized, developmentally appropriate, culturally relevant, evidence-based, and reinforced across multiple settings, including schools, the home, healthcare environments, community organizations, workplaces, and public assistance programs.

Nutrition education should recognize that individuals and families make food decisions within the context of their resources, food access, cultural traditions, health status, and daily demands. As a result, educational approaches should emphasize practical application, realistic behavior change, and the ability to identify healthy options within a variety of circumstances rather than a single prescriptive approach to eating.

A review of the current Texas nutrition education landscape demonstrates that nutrition education is not confined to a single curriculum or instructional model. Rather, Texas has developed a diverse nutrition education ecosystem supported by state agencies, universities, Texas A&M University AgriLife and Prairie View A&M University extension programs, school nutrition programs, nonprofit organizations, community partners, and healthcare organizations. These entities collectively provide opportunities to strengthen food literacy and healthy eating behaviors across the lifespan while leveraging existing educational and community infrastructure.

We recommend the following core concepts as educational themes at every level and have further advised age and training level-specific recommendations.

From Curriculum to Culture: A Feasible Approach

One of the most significant observations from the Texas nutrition education landscape is that successful nutrition education in Texas does not depend solely on adopting a comprehensive curriculum. Rather, the strongest programs create a culture of healthy eating by leveraging existing staff, instructional time, and school activities.

This approach is particularly important because Texas schools vary considerably in size, staffing, resources, and community context. A small rural district with one campus and a single Child Nutrition Director has vastly different operational capacities

than a large urban district with dedicated wellness coordinators and Farm to School staff. Likewise, educators and administrators continue to balance numerous instructional and operational priorities, making it beneficial for nutrition education efforts to build upon existing structures whenever possible.

Guiding Principles

At their core, successful nutrition education initiatives should strive to be:

- Integrated rather than additive.
- Cross-functional rather than department-specific.
- Flexible enough to fit local context.
- Low-cost and sustainable.
- Capable of being implemented incrementally.

Meet Each Population at the Right Place

Nutrition and metabolic health education can benefit Texans across all stages of life. Opportunities exist to strengthen nutrition knowledge and practical skills among children, adolescents, college students, parents and caregivers, healthcare professionals, older adults, and community members. Each group needs tailored educational strategies, resources, and support structures to facilitate success in healthy dietary change. Because nutrition-related decisions are made daily and influence long-term health outcomes, educational strategies should support lifelong learning and reinforce key concepts through multiple touch points over time.

A continuum approach to nutrition education recognizes that learning evolves across developmental stages from early food exposure and sensory exploration in young children to food literacy, culinary skills, consumer decision-making, and independent application in adolescence and adulthood. Effective educational approaches build progressively while remaining flexible enough to reflect local culture, available resources, and the diverse settings in which Texans learn, work, and access food.

Food and Culinary Skills Framework

Effective educational content moves beyond awareness of nutrition concepts alone and incorporates food and culinary skills that help individuals translate knowledge into practical action. Core concepts beyond understanding dietary patterns may include food preparation and meal planning skills, food budgeting, label interpretation, food safety, and healthy food selection and storage. Educational approaches must

prioritize practical skills that empower individuals and families to make informed decisions within their own cultural, social, and economic contexts.

Food literacy is strengthened through experiential learning opportunities that allow individuals to connect nutrition concepts to everyday life. Gardening activities, food preparation experiences, culinary demonstrations, sensory food exploration, taste testing, and farm-to-school or farm-to-community activities can reinforce nutrition education while building confidence and self-efficacy. These approaches help learners develop not only knowledge, but also the practical skills necessary to apply that knowledge in real-world settings.

Education at Points of Access and Assistance

Programs that support food access also represent valuable opportunities for nutrition education and skill building. Federal nutrition assistance programs such as SNAP, WIC, and school meal programs, as well as charitable food systems including food banks, food pantries, and community food distribution organizations, frequently serve as trusted points of contact for individuals and families seeking food support.

In addition to providing access to food, many of these programs deliver nutrition education, cooking demonstrations, resource navigation, health screenings, and connections to community services. Integrating practical nutrition education into food access settings helps reinforce healthy dietary patterns while supporting participants' ability to apply nutrition knowledge in real-world circumstances. These approaches create opportunities to simultaneously address food access, food literacy, and long-term health outcomes.

In Texas, the strong existing program infrastructure across schools and communities can be leveraged to deliver and reinforce nutrition education with efficient use of resources. These established systems may provide practical and sustainable opportunities to expand nutrition education with additional support and resources.

Evidence-Based Educational Strategies

Educational strategies should prioritize approaches that have demonstrated effectiveness in improving knowledge, skills, self-efficacy, and sustainable health-related behaviors. Examples include:

- Experiential learning
- Culinary and food preparation activities
- Case-based learning

- Peer and family engagement
- Behavior change techniques
- SMART goal setting
- Environmental supports
- Reinforcement through repeated exposure and empowerment

Educational initiatives should be tailored to the needs of specific audiences while emphasizing practical application and opportunities for sustained behavior change.

Educator Training and Implementation Support

Successful implementation of nutrition and health education will likely require access to evidence-based curricula, professional development opportunities, implementation support, and sufficient flexibility for local adaptation. As with other educational initiatives, nutrition education will be most sustainable when accompanied by practical resources and support, including time allocation.

Teacher training and implementation support represent promising strategies for expanding nutrition education capacity while reducing burden on schools. Professional development programs can equip teachers, school nutrition professionals, and other staff with the knowledge, skills, and confidence to deliver nutrition, gardening, food literacy, culinary, and related health content within existing educational frameworks. Effective models often include standards-aligned curricula that integrate nutrition concepts into existing academic content, ongoing coaching and technical assistance to support implementation, and adaptable resources that allow schools to tailor programming to local needs while maintaining fidelity to evidence-based practices.

A coordinated approach to professional nutrition learning for educators and practical implementation support may also strengthen collaboration across departments and disciplines. Nutrition education can be reinforced by educators, school nutrition professionals, school nurses, wellness coordinators, Extension agents, afterschool providers, and community partners, each contributing through their own area of expertise. Professional development may focus on integrating nutrition education into existing educational activities, supporting experiential learning and food literacy, fostering positive food environments, and strengthening collaboration among educators, school nutrition professionals, families, and community partners.

Leveraging Higher Education Partnerships

Partnerships between K–12 schools, community colleges, and universities may represent an additional strategy for expanding nutrition education capacity. Programs that engage undergraduate and graduate students in nutrition, public health, education, agriculture, food systems, and health-related disciplines can provide experiential learning opportunities while supporting nutrition education delivery in schools and communities. For example, The University of Texas at Austin offers an undergraduate two-semester course, NTR 365 Community Engagement, where undergraduates are partnered with teachers to lead a series of nutrition, gardening, and cooking lessons for elementary school children. See an example syllabus in the **Evidence-Based School Support Resources & Examples Appendix D**. This model may be used in other colleges/universities to simultaneously strengthen K–12 education efforts, support local implementation capacity, and contribute to development of the future health and nutrition workforce.

Institutions of higher education may also serve as valuable partners in curriculum development, educator preparation, professional development, program evaluation, and applied research. In addition, universities can support the translation of emerging nutrition and metabolic health science into practical educational strategies that are appropriate for schools and communities.

Texas is well-positioned to leverage these partnerships through its network of public universities, extension programs, academic health centers, and community colleges. Existing collaborations among institutions of higher education, schools, school nutrition programs, early childhood providers, and community organizations create opportunities to share expertise, provide technical assistance, and expand access to evidence-based nutrition education resources.

See additional Texas-based examples of these strategies in the **Evidence-Based School Support Resources & Examples Appendix D.**

Settings-Based Implementation

Primary Education (Kindergarten–Grade 8)

Legislative Context

Senate Bill 25 (89th Texas Legislature) establishes nutrition education requirements within Texas public schools and recognizes the importance of providing students with age-appropriate instruction related to nutrition and metabolic health. These provisions

reflect growing recognition that nutrition-related knowledge, attitudes, and behaviors begin developing early in life and can influence health, academic performance, and well-being throughout adulthood.

Background

Elementary and middle school years represent a critical period for establishing food preferences, dietary habits, and foundational health literacy. During these years, children begin making increasingly independent food choices while also developing the knowledge and skills needed to understand how food supports growth, learning, physical activity, and overall health.

Nutrition education during childhood is not solely about preventing future disease; it is also about helping students develop food literacy, critical thinking skills, and practical knowledge needed to navigate an increasingly complex food environment throughout their lives. Educational approaches are most impactful when they help students develop practical skills (including food preparation and cooking skills), understand the relationship between food and health, and build confidence in making informed decisions within real-world settings. Age-appropriate, engaging, and experiential learning opportunities can help students connect nutrition concepts to everyday life while fostering a positive relationship with food and lifelong healthy habits. Nutrition education should be developmentally appropriate, building progressively from food exposure, sensory food exploration, and basic food literacy in younger children toward more advanced concepts such as food marketing, nutrition information, consumer decision-making, culinary skills and health literacy as students mature. This continuum recognizes that healthy eating behaviors are developed over time through repeated exposure, positive experiences, and opportunities for active participation.

Schools provide an important setting for nutrition education because they reach children across diverse geographic, cultural, and socioeconomic backgrounds. However, one of the key observations from scanning the Texas nutrition education landscape is that nutrition education is not confined to a single classroom or curriculum. Rather, it can be reinforced across multiple components of the school environment, including:

- Classroom instruction
- School nutrition programs
- Gardens
- Culinary and food preparation activities
- Farm to School initiatives

- Family engagement efforts
- Community partnerships

Effective programs recognize that students encounter nutrition information from many sources and emphasize practical food literacy and age-appropriate decision-making skills. When nutrition concepts are reinforced, students have multiple opportunities to apply and strengthen their understanding over time. This integrated approach allows schools to build a culture of healthy eating without requiring nutrition education to exist as a standalone program. Nutrition education can support a positive relationship with food by emphasizing balance, variety, practicality, enjoyment, cultural relevance, and informed decision-making. Educational approaches that avoid fear-based or stigmatizing messaging can help students develop healthier lifelong attitudes toward eating while supporting food literacy and self-efficacy. Approaches that center around what children can do, explore, and experience rather than what they should or should not do empowers students to build long lasting healthy behaviors.

Research conducted in Texas provides additional evidence supporting experiential school-based nutrition education. The TX Sprouts cluster randomized controlled trial demonstrated improvements in vegetable consumption, overall diet quality, metabolic health indicators, and academic outcomes through an integrated gardening, nutrition, and cooking intervention delivered in elementary schools.[322–324] Additional analyses found increased consumption of minimally processed foods and reductions in ultra-processed food intake, supporting the potential value of hands-on, school-based approaches to nutrition education.[325]

Additional evidence from the Texas Grow! Eat! Go! five-year randomized controlled trial evaluated a family-focused school garden, nutrition, and physical activity intervention.[326] Findings demonstrated that schools can positively influence students' healthy eating behaviors with participating children showing increased knowledge of nutrition and plant science, as well as significant improvements in vegetable preference and consumption during school meals. The intervention also contributed to increases in parent and student engagement in gardening, meal preparation, and shared mealtimes at home, underscoring the broader reach of school-based, experiential programs.

Importantly, successful implementation does not necessarily depend on adoption of a single comprehensive curriculum. Numerous opportunities for Texas schools to integrate nutrition education through existing instructional activities and operational structures currently exist. Cafeterias, school gardens, Farm to School initiatives, family engagement events, wellness activities, and partnerships with community organizations all provide opportunities to reinforce nutrition concepts while minimizing

additional burden on educators and school staff. This flexible approach allows districts of varying size, geography, and resource capacity to identify implementation strategies that best align with local priorities and needs.

Leveraging Existing Educational & Nutrition Infrastructure

Texas schools are not starting from scratch. Existing educational, health, and community partnerships provide opportunities to support nutrition and metabolic health education through multiple channels. School districts, School Health Advisory Councils (SHACs), early childhood education programs, school nutrition programs, teacher organizations, parent engagement efforts, institutions of higher education and community partners can all contribute to implementation in ways that align with local needs and resources.

A review of the current Texas nutrition education landscape demonstrates that the state has developed a diverse and well-established nutrition education ecosystem. State agencies, universities, extension programs, nonprofit organizations, school nutrition departments, healthcare organizations, and community partners collectively provide a range of publicly available and low-cost nutrition educational resources and implementation supports that can be leveraged to strengthen nutrition and metabolic health education. Many of these resources are designed to integrate naturally into existing school operations and infrastructure, providing flexibility for local adaptation and multiple entry points for implementation without requiring the development of entirely new systems.

Notably, more than 55% of Texas school districts are classified as rural based on the National Center for Education Statistics (NCES). Rural schools tend to have fewer resources available to support nutrition education. As such, alternative methods may include virtual nutrition education training and telehealth to ensure all Texas children have access to nutrition education. For example, the Texas A&M University Telehealth Institute currently uses Project ECHO format to distribute educational information to rural and underserved areas, a strategy which could potentially scale.[327]

Table 5. Nutrition integration opportunities across school learning environments.

School Environment	Potential Opportunities
Classroom Instruction	Evidence-based curricula, science and health lessons
School Nutrition Program	Taste tests, sensory food exploration, menu education, cafeteria signage
Farm to School	Local food promotions, producer visits

School Environment	Potential Opportunities
School Gardens	Plant science, harvesting, food systems
Culinary Education	Cooking demonstrations, recipe development, food preparation skills
Family & Community Engagement	Family nights, newsletters, community gardens, family nutrition education
Professional Development	Nutrition education training for educators and nutrition staff, responsive feeding practices
Afterschool Programs	Gardening, cooking, and nutrition education clubs
SHAC & Wellness Committees	Planning and local wellness policy support, school nutrition, student ambassador programs

Efforts may be strengthened through a coordinated approach consistent with the Whole School, Whole Community, Whole Child (WSCC) framework[328], which recognizes that student health and academic success are interconnected and influenced by multiple aspects of the school environment. Nutrition education is most effective when reinforced across classroom instruction, school meals, physical activity, family engagement, school gardens, culinary experiences, and community partnerships rather than delivered as a standalone topic.

Similarly, existing local structures such as SHACs and Local Wellness Policies provide natural opportunities to incorporate nutrition education planning and reinforce healthy school environments. These mechanisms can help align nutrition education activities with broader district wellness goals while providing flexibility for local adaptation.

Leveraging existing infrastructure may help schools integrate nutrition education efficiently while minimizing administrative burden and maximizing opportunities for reinforcement across the school environment. This approach may be particularly important as schools continue to balance varying local priorities, staffing models, and resource capacities and seek long-term program sustainability.

School Nutrition Programs as Educational Partners

School nutrition programs play an important educational role in schools by connecting nutrition concepts to students' daily experiences. While classroom instruction provides foundational knowledge, cafeterias offer opportunities for students to apply that learning through real-world food choices and experiences. School nutrition professionals, including registered dietitians, other nutrition directors, and cafeteria staff, can reinforce healthy eating behaviors through food exposure, nutrition messaging, and positive interactions that help students build food literacy and confidence.

Nutrition education can be integrated into the school day through strategies that encourage exploration of new foods and healthy eating habits. These experiences can complement classroom instruction while creating consistent nutrition messaging across the broader school environment. As schools seek practical approaches to improving nutrition knowledge and behaviors, school nutrition departments represent an existing and often underutilized partner in nutrition education efforts.

Examples of promising strategies include:

- Taste test and food exploration activities
- Harvest of the Month programs
- Farm Fresh Challenges and other farm-to-school activities
- School gardens and hydroponic growing projects
- Nutrition lessons delivered by nutrition educators and health educators
- Healthy recipe sharing with families
- Culinary education activities and hands-on food preparation experiences

These efforts help students build food literacy, increase exposure to fruits and vegetables, strengthen connections to agriculture and food systems, and reinforce healthy eating behaviors through experiential learning.

School nutrition programs also serve as important connectors between schools, families, and communities. Many districts engage parents and caregivers through family education events, newsletters, and wellness initiatives that extend nutrition learning beyond the school campus. These efforts recognize that food choices and eating behaviors are shaped not only at school but within communities.

Experiences shared by Texas school nutrition leaders highlight the value of integrating registered dietitians and nutrition professionals into school-based programming, aligning cafeteria offerings with educational goals, fostering cross-sector partnerships, and creating opportunities for experiential learning. Together, these collaborative efforts demonstrate how school nutrition programs can serve as important educational partners in providing nutrition education and supporting student health, food literacy, and lifelong healthy habits.

Importantly, successful implementation does not require every district or program to adopt the same model. The Texas nutrition education landscape demonstrates that schools can enter through multiple pathways depending on local priorities, staffing structures, and available resources. For some, this may involve simple cafeteria-based nutrition messaging or annual participation in initiatives such as Texas Fruit and

Vegetable Day or Texas Farm Fresh Challenge. Others may build upon existing wellness initiatives through school gardens, culinary activities, family engagement efforts, or broader Farm to School programming. This flexibility allows nutrition education to be integrated into existing operations in ways that are practical, scalable, and responsive to local needs while creating meaningful opportunities for students to develop food literacy and lifelong healthy habits. School nutrition programs can serve as important education partners by creating a coordinated system of complementary experiences that reinforce food literacy throughout the school environment.

Additional district examples, implementation models, and Texas-based resources are provided in the **Evidence-Based School Support Resources & Examples Appendix D.**

External Partnerships and Implementation Support

External organizations can play an important role in supporting local implementation of nutrition and metabolic health initiatives. Schools and districts often face competing priorities, limited staff capacity, and resource constraints when seeking to strengthen nutrition education and school food environments. Partnerships with nonprofit organizations, colleges and universities, extension programs, public health agencies, community organizations, and technical assistance providers may help schools access evidence-based resources, implementation support, professional development opportunities, grant funding, and peer learning networks.

A review of the Texas nutrition education landscape demonstrates that the state benefits from an extensive network of partners that already contribute to nutrition education and food literacy efforts. State agencies, universities, extension programs, agricultural and food system partners, healthcare organizations, school nutrition departments, food banks, nonprofit organizations, and community groups collectively provide educational resources and implementation support that can be leveraged to strengthen local programming. By building upon these existing assets, schools and communities may be able to expand nutrition education opportunities while minimizing the need for new infrastructure.

Texas A&M AgriLife Extension Service serves all 254 Texas counties through a statewide network of professional educators, trained volunteers, and county offices, positioning it as a uniquely capable external partner for schools implementing evidence-based nutrition initiatives. Through its Family and Community Health (FCH) program, AgriLife Extension delivers science-based, community-responsive education designed to improve the health and well-being of individuals, families, and communities. By providing research-grounded curricula, hands-on learning

experiences, and sustainable solutions tailored to local needs, AgriLife Extension offers schools robust implementation support that enhances the reach and impact of school-based nutrition efforts across Texas. AgriLife Extension also supports evidence-based school wellness efforts through initiatives such as the Healthy School Campus recognition program, which provides resources and programming for elementary and middle school students and their caregivers, including school staff and parents. These collaborative approaches may be particularly valuable in rural and underserved communities, where partnerships can help expand access to specialized expertise and educational opportunities that may not otherwise be readily available.

A national example is the Eat Real K–12 Certification Program, a nonprofit initiative that works directly with school nutrition leaders to assess and strengthen school food environments through evidence-based standards related to nutrition, menu quality, food literacy, student engagement, and operational practices.[329] The program (free to districts) provides districts with technical assistance, benchmarking, implementation support, and opportunities to learn from peer districts while allowing flexibility to adapt strategies to local circumstances. Recently expanded into Texas, programs such as Eat Real may provide additional support for districts seeking to advance nutrition and metabolic health goals while building on existing school nutrition infrastructure.

Texas has a rich network of organizations and partnerships supporting nutrition education. The opportunity lies in leveraging and coordinating those existing assets rather than creating entirely new structures. Strengthening communication and collaboration across sectors may help maximize the collective impact of these efforts while creating a more connected and sustainable approach to nutrition education.

Conclusions

Consistent with the intent of Senate Bill 25, nutrition education in elementary and middle school should emphasize practical skills, healthy dietary patterns, food literacy, and age-appropriate understanding of nutrition and metabolic health. Educational approaches should remain flexible enough to meet the needs of local communities while supporting foundational competencies that prepare students for lifelong health and well-being. Nutrition education should be integrated across multiple components of the school environment, including classroom instruction, school nutrition programs, gardens, culinary experiences, family engagement activities, and community partnerships.

Lasting impact will likely depend not only on what is taught, but also on the systems and support available to schools. Access to evidence-based curricula, professional development, technical assistance, community partnerships, and sustainable

implementation resources may help districts deliver high-quality nutrition education while minimizing administrative burden.

Collectively, these recommendations support a collaborative, systems-based approach to nutrition education that emphasizes practical application, experiential learning, and reinforcement across multiple settings. By leveraging existing educational, school nutrition, and wellness infrastructure and resources while allowing flexibility for local adaptation, Texas can support a coordinated approach that helps students develop the knowledge, skills, and confidence needed to navigate an increasingly complex food environment throughout their lives.

High School and Postsecondary Education

Legislative Context

Senate Bill 25 (89th Texas Legislature) encourages elective nutrition and metabolic health education opportunities for older students as they prepare for greater independence in food-related decision-making, higher education, and future careers. High school and post-secondary settings provide important opportunities to build upon foundational nutrition knowledge acquired during earlier educational experiences and to introduce more advanced concepts related to health, wellness, food systems, and career pathways.

Background

Adolescence and early adulthood represent critical periods for developing lifelong health behaviors. During these years, individuals gain increasing autonomy over food purchasing, meal preparation, and dietary choices while often encountering new environments, responsibilities, and influences. High school and post-secondary education provide important opportunities to build upon the foundational nutrition and health concepts introduced during childhood and adolescence. Educational experiences during high school and postsecondary education can help students develop the knowledge, skills, and confidence needed to navigate increasingly complex food environments and make informed decisions that support long-term health and well-being.

At these educational levels, nutrition and metabolic health concepts may be incorporated through health and wellness courses, career and technical education programs, agriculture and food science programs, culinary arts courses, health sciences pathways, dual-credit and collegiate opportunities, campus wellness initiatives, experiential learning, and peer-led or student-run leadership organizations. These settings also provide opportunities to explore the connections among nutrition,

metabolic health, physical activity, academic performance, workforce readiness, and chronic disease prevention.

Educational approaches may benefit from emphasizing practical life skills such as meal planning, food preparation, budgeting, label interpretation, critical evaluation of nutrition information from a variety of sources and navigating food choices in real-world settings. As students prepare for careers and independent living, nutrition education can also increase awareness of health-related professions and support workforce development in fields such as healthcare, nutrition, public health, agriculture, food systems, and education.

Promising Strategies

As with elementary and middle school education, successful implementation at the high school and postsecondary levels does not necessarily require the development of entirely new programs. The Texas nutrition education landscape suggests that many opportunities already exist within current educational structures, including career and technical education pathways, school nutrition programs, campus wellness initiatives, extension programming, and existing community partnerships. Leveraging these systems may provide flexible and sustainable opportunities to reinforce nutrition and metabolic health education while accommodating the diverse needs and resources of local communities.

Examples of approaches that may support nutrition and metabolic health education among high school and postsecondary learners include:

- Career and Technical Education pathways in health sciences, culinary arts, agriculture, and food science.
- Experiential learning opportunities, including cooking, gardening, food systems, and community engagement activities that connect nutrition concepts to real-world application.
- Campus wellness initiatives that integrate nutrition and food access, physical activity, sleep, stress management, and mental well-being.
- Peer-to-peer education and student leadership opportunities, including student interest groups, mentoring programs, and nutrition and health ambassador models that encourage students to lead and learn from one another.
- Partnerships among primary/secondary schools, colleges and universities, and community organizations.

- Dual-credit and interdisciplinary coursework that connects nutrition and metabolic health concepts to real-world applications and career exploration across disciplines.
- Implementation of Future Farmers of America (FFA)[330], Family, Career and Community Leaders of America (FCCLA)[331], and Extension 4-H Programs[332] that are dedicated to high school age students. An example includes the Healthy Texas Youth Ambassador Program.[333] These programs train young people to change their lifestyles for health improvement and to motivate peers to do the same.

Nutrition and metabolic health education in high school and postsecondary settings should emphasize practical application, independent decision-making, and workforce development. Flexible educational pathways can allow institutions to align programming with local needs (including community partnerships and service-learning opportunities) and student interests while helping prepare future generations to navigate food and health decisions across the lifespan.

Notably, while addressing more advanced learners, many core concepts and strategies described in the preceding section focused on primary education remain true, particularly the importance of leveraging and supporting existing infrastructure and cultivating cross-sector partnerships.

Unique Opportunities for Secondary and Postsecondary Education Programs

High school students have diverse interests, academic goals, and career aspirations, creating opportunities for nutrition education beyond foundational health instruction. In addition to supporting personal health and well-being, nutrition concepts can be integrated into courses and programs related to health sciences, agriculture, food systems, culinary arts, public health, exercise science, and other career and technical education pathways.

Secondary education settings also provide opportunities for students to explore nutrition as an academic and professional field. Exposure to nutrition-related careers can help students understand the role of nutrition in healthcare, community health, food systems, research, education, and industry while supporting workforce development needs across Texas. Schools and districts may consider flexible approaches that align nutrition education with local priorities, workforce needs, and existing academic programs while creating opportunities for students to develop knowledge and skills that support lifelong health.

Some Texas institutions have developed undergraduate pathways that reflect the interdisciplinary nature of nutrition. For example, programs at many Texas universities integrate coursework in biological sciences, health sciences, and food systems, illustrating how nutrition education can connect multiple disciplines and prepare students for a variety of academic and professional pathways.

Secondary education programs can contribute to increasing nutrition literacy to students who are nutrition majors, non-nutrition majors who want to learn about nutrition, or those interested in attending medical and allied health professional schools. Including integrative nutrition science courses as traditional science prerequisites for health professional education could provide an effective foundation and improve health system emphasis on prevention and wellness.

Additional strategies specific to post-secondary education include:

- Courses: Offering nutrition courses as options in the college/university core curriculum offerings, offering nutrition electives and specific courses for students who are preparing for medical school and allied health professional programs, cross-listing nutrition-focused courses with other departments.
- Minors and Culinary Certificate Programs: Offering a nutrition minor can promote evidence-based nutrition knowledge to students who are majoring in other areas; Certificate programs in culinary nutrition can help students to learn more healthful strategies that contribute to personal and professional goals.
- Campus Workshops & Presentations: Interactive sessions on cooking in dorm rooms or at home, nutrition basics, meal planning, food budgeting guidance and grocery store tours.
- Online Resources: Accessible guides, apps, and webinars tailored to student needs including food access.
- Peer Education Programs: Students teaching students through organizations, mentoring, and outreach.
- Dining Services Initiatives: Healthier menu options, food labeling, and nutrition information available online and in cafeterias.
- Social Media Campaigns: Quick tips, myth-busting facts, and recipe shares, targeting students developed by credible nutrition experts such as registered dietitians.

Nutrition Education Support Needed

Texas universities have highly trained nutrition faculty, including registered dietitians and nutrition scientists, who are actively educating students and future healthcare professionals. These faculty members are well positioned to support the increased need for nutrition courses that would come with offering them as options in the college/university core curriculum, nutrition electives, and nutrition courses for students who are preparing for medical school and allied health professional programs. However, many universities rely on a relatively small number of faculty with the expertise required to teach rigorous nutrition coursework. The implementation of more nutrition courses in postsecondary institutions will increase teaching demand and create the need for increased faculty capacity and appropriate resources.

In addition to formal coursework expansion, colleges/universities can emphasize access to registered dietitians at health services locations to assist with the diverse mental and physical needs of students, especially with the high incidence of mental health issues, including but not limited to, eating disorders. Registered dietitians can see students at a reduced cost and help them in developing healthier relationships with food as well as managing mental health and chronic disease challenges.

Food access also represents an important consideration for student success. Campus food pantries and other food assistance initiatives can help ensure that students from diverse cultural and socioeconomic backgrounds have access to the nutritious foods needed to support academic performance and overall well-being. Research on college pantries shows that long-term success depends on institutionalizing the pantry through stable funding, administrative support, and community partnerships.[334]

Conclusions

In summary, high school and postsecondary education represent critical junctures for empowering young people with the nutrition knowledge and skills essential for lifelong health and well-being. Senate Bill 25 and evolving educational practices in Texas recognize the importance of preparing students for independent living, informed decision-making, and workforce readiness by integrating comprehensive, practical nutrition and metabolic health education into curricula and campus life. These efforts are strengthened by leveraging existing academic pathways, experiential learning, and innovative programming, ensuring nutrition education is accessible to both nutrition majors and students from diverse fields.

Post-secondary education strategies, such as incorporating nutrition-integrated science courses, expanding nutrition course offerings, and bolstering campus support services, demonstrate promising progress across the state. However, realizing the full potential

of nutrition education requires ongoing commitment to faculty development, cross-disciplinary collaboration, and the provision of resources that support both academic and holistic student success, including food access and dietary health support by registered dietitians.

By continuing to expand educational opportunities and support systems, Texas can cultivate a new generation of health-literate, resourceful, and resilient individuals who are equipped to navigate complex food environments, make informed choices, and contribute meaningfully to the health of their communities and the broader society. Ongoing innovation, collaboration, and investment in nutrition education at the secondary and post-secondary levels will be essential to advancing public health and addressing the challenges of chronic disease prevention in the years ahead.

Future Considerations

Potential areas for future exploration may include:

- Development of a centralized Texas nutrition education resource directory.
- Enhanced coordination among state agencies, educational institutions, and community partners.
- Additional support for middle, high school, and collegiate nutrition education programming.
- Further exploration of culinary, agricultural and food literacy education opportunities across the educational continuum.
- Further exploration of technology in providing nutrition education to students and continuing education to teachers and administrators in rural schools.
- Examination of policy mechanisms that encourage integration through existing regulatory, educational, and accountability structures.
- Continued recognition of school nutrition departments/food service staff as key contributors to nutrition education and student food literacy.
- Increased state funding support and/or grant opportunities to strengthen nutrition education initiatives and support professional development for educators and school nutrition personnel.
- State support for communication, dissemination, and integration of the future Texas Dietary Guidelines into existing and emerging nutrition education initiatives.

Final Summary of Primary, Secondary, and Postsecondary Nutrition Education Strategies

Across educational settings, successful nutrition education strategies share several common characteristics: they are integrated into existing learning environments, reinforced through practical and experiential learning opportunities, supported by trained educators and institutional leadership, and adapted to local needs and resources. While implementation approaches may differ across K–12 schools, career and technical education programs, colleges, and universities, the overarching goal remains the same: to equip Texans with the knowledge, skills, and confidence needed to make informed food and nutrition decisions throughout their lives. Expanded investment in educator and program support, cross-sector partnerships, and evidence-informed resources can help strengthen nutrition education opportunities across the educational continuum.

Health Professional Education Recommendations

Nursing Education

Legislative Context

Senate Bill 25, enacted by the 89th Texas Legislature, established a continuing education requirement in nutrition and metabolic health for licensed nurses and directed that educational content be based on nutritional guidelines recommended by the TNAC. As these requirements are implemented, there is an opportunity to advance nursing education in nutrition and metabolic health and strengthen the capacity of nurses to support health promotion, chronic disease prevention, and patient-centered care across Texas.

Background

Nurses play a critical role in health promotion, chronic disease prevention, patient education, care coordination, and community health. As one of the most trusted health professions and the largest segment of the healthcare workforce, nurses are uniquely positioned to help individuals and families understand the relationship between nutrition, lifestyle behaviors, and long-term health outcomes.

Despite the substantial role nutrition plays in many chronic conditions, nutrition education in nursing preparation and continuing education varies considerably. Historically, nutrition education for nurses has been limited to one course. Because this course introduces the concept of nutrition science, including the concepts of nutrients, dietary patterns, and implementing healthier diets, nurses may feel unprepared to translate nutrition science into clear, actionable, guidance for patients. Increasing the amount of nutrition education nurses receive and spreading it more evenly throughout the curriculum could help nurses improve their skill and confidence in screening for and managing nutrition risk and providing basic nutrition education and support for behavior change.

Implementation in Nursing Education

Nutrition and metabolic health concepts may be incorporated across undergraduate nursing education, graduate nursing education, and continuing nursing education

programs. Educational efforts should emphasize practical application and patient communication in addition to foundational scientific concepts.

Key educational topics may include:

- Principles of healthy dietary patterns and overall diet quality.
- Nutrition's role in metabolic health and chronic disease prevention.
- The impact of food choices on cardiovascular, metabolic, gastrointestinal, cognitive, and overall health.
- The role of UPF and dietary patterns in health outcomes.
- Lifestyle factors that interact with nutrition, including physical activity, sleep, stress management, and social determinants of health.
- Strategies for translating dietary guidance into practical, culturally relevant, and affordable recommendations at the bedside.
- Approaches to behavior change, motivational interviewing, and patient-centered conversations.

Educational content should prioritize clear, actionable concepts that nurses can readily apply in patient care and community settings.

Application in Clinical Practice

Nurses routinely educate patients during clinical encounters, care transitions, chronic disease management visits, and community-based programs. Strengthening nursing competency in nutrition and metabolic health can enhance the ability of nurses to support patients in making informed dietary and lifestyle decisions.

Rather than focusing solely on nutrient targets or disease-specific restrictions, nutrition education should equip nurses to help patients understand how dietary patterns influence health, identify common misconceptions, and implement realistic changes within the context of their personal circumstances, culture, food access, budget, and preferences.

Continuing education requirements focused on nutrition and metabolic health provide an opportunity to reinforce evidence-based knowledge, improve confidence in patient counseling, and promote consistent messaging across healthcare settings. Educational approaches that connect nutrition science with practical implementation strategies may be particularly valuable in helping nurses support sustainable behavior change and improve population health outcomes.

Using hypertension as an example, nursing education could better emphasize evidence-based approaches for both diet and lifestyle components in the care of patients with hypertension, such as the well-studied DASH dietary pattern.[335] Nurses can impact patient uptake of DASH educational tools and discuss the complexity of making dietary changes in real life contexts. Guidance must be practical and easy to follow to support adherence and improve health outcomes, and nurses are well-positioned to serve as conduits for patient understanding and to reinforce guidance from dietitians and other health professionals.

Conclusion and Future Implications

Nutrition education for nurses delivered through integrated, interprofessional teaching models represents a critical step in improving how nutrition is applied in clinical care. Treating nutrition as a clinical intervention defined by measurable intake and expected outcomes provides the foundation for consistent implementation, evaluation, and improvement of dietary strategies.

Sustaining this progress requires support beyond clinical education. Digital tools, community-based initiatives, federal nutrition programs and other practical implementation models help reinforce nutrition knowledge and support long-term behavior change in real-world settings.

The TNAC encourages the Texas Board of Nursing and nursing education stakeholders to support continuing education and professional development opportunities focused on nutrition and metabolic health, emphasizing practical patient counseling, dietary pattern–based approaches, and real-world implementation strategies for chronic disease prevention and management.

Undergraduate Medical Education (Medical Schools)

Legislative Context

Senate Bill 25 (89th Texas Legislature) requires Texas medical schools to provide instruction in nutrition and metabolic health and directs that educational content be informed by nutritional guidelines developed by the TNAC. This requirement reflects growing recognition that nutrition, dietary patterns, and metabolic health are foundational to the prevention and management of many of the chronic diseases that contribute substantially to morbidity, mortality, and healthcare costs in Texas.

Importantly, the goal of Senate Bill 25 is not simply to increase the number of hours devoted to nutrition education, but to ensure that future physicians develop the knowledge, skills, and attitudes necessary to incorporate nutrition and metabolic health into patient care. Effective programs increasingly emphasize longitudinal integration throughout the curriculum, interdisciplinary collaboration, behavior change counseling, and practical application within clinical settings.

While nutrition is relevant across nearly every medical specialty, previous studies have identified variability in the quantity, timing, and delivery of nutrition education within undergraduate medical education. As Texas medical schools implement the requirements of Senate Bill 25, there is an opportunity to evaluate current educational approaches, identify best practices, and better understand the perspectives of both learners and educators regarding nutrition and metabolic health training. The following sections summarize the current evidence related to nutrition education in medical schools, describe existing educational models, and highlight opportunities for future development, including medical student-informed perspectives and recommendations.

Background

While there are several factors that impede physicians' ability to address diet with patients, inadequate training is a consistently cited barrier.[336,337] Medical students,[338] residents,[339] and practicing physicians[340] all recount poor nutrition training throughout medical education. Senior medical students have described that their curriculum did not prioritize nutrition, and specifically that it failed to bridge nutrition concepts to clinical practice.[341] Residents agree their training during medical school was insufficient, with 79% of surveyed U.S. interns reporting medical school left them underprepared to incorporate clinical nutrition in practice.[342] The American Medical Association (AMA) Council on Foods and Nutrition has also acknowledged that inadequate nutrition education affects physicians' ability to answer patient questions related to diet and health.[343]

This deficit has prompted professional, academic, and political leadership to advocate for improved nutrition in medical education over several years. The U.S. Preventive Services Task Force, American Heart Association, and other practice-based organizations have stipulated physician nutrition training is necessary to prepare physicians to deliver practice-based guidelines around nutrition care.[344-346] Medical educators and accrediting organizations have also outlined education priorities and offered strategic plans for curriculum development.[344,346-348] The National Heart, Lung, and Blood Institute (NHLBI) and National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) initiated the Nutrition Academic Award which provided

funding to 21 medical schools to develop nutrition education interventions in efforts to formally integrate nutrition in medical school curriculum.[345]

Decades of effort have amounted to some success, with the most recent data from Association of American Medical Colleges (AAMC) polling that 100% of surveyed medical schools reported that nutrition was addressed in their required curriculum.[349] This represents improvement from a prior national survey, where only a quarter of institutions met the minimum required curricular hours for nutrition.[350] However, there is wide variation that exists among these nutrition education initiatives, which makes it difficult to understand which approaches are most effective in preparing learners to address diet with patients.[351]

Medical education is increasingly shifting from a sole focus on nutrition knowledge acquisition toward the development of practical skills that support behavior change and implementation. Future physicians should be prepared not only to understand the relationship between nutrition and health, but also to engage patients in realistic discussions about dietary change. Training in collaborative goal setting, motivational interviewing, shared decision-making, and referral to interdisciplinary team members can help learners translate evidence-based nutrition guidance into achievable actions that align with patients' values, resources, and lived experiences.

Nutrition and metabolic health education is most effective when integrated longitudinally throughout medical training rather than delivered as a single, isolated course. There is need for a focus on translation of nutrition knowledge into patient care settings, making clinical rotations a key opportunity for the integration of tools that support immediate clinical application. Because medical schools vary in their educational models, patient populations, clinical partnerships, and available expertise, implementation should be tailored to local contexts and led by interdisciplinary teams with appropriate institutional support. Investment in faculty expertise, curricular infrastructure, clinical learning opportunities, and community partnerships can help ensure that nutrition and metabolic health competencies are meaningfully incorporated into medical education and translated into future clinical practice.

Student Perspectives on Nutrition Education Across Texas Medical Schools

Nutrition is central to the prevention and management of many chronic diseases, yet medical students across Texas described a persistent gap between the recognized importance of nutrition in patient care and the training they currently receive to address it in practice. This qualitative analysis drew on interviews with 18 unique medical student participants across all 14 Texas medical schools receiving state

funding to better understand how students perceive the current status of nutrition education, how prepared they feel to counsel patients, what nutrition-related responsibilities they believe physicians should hold, and what educational approaches are most likely to be effective and feasible. The full data and analysis are included in the **Medical Student Perspectives Appendix E.**

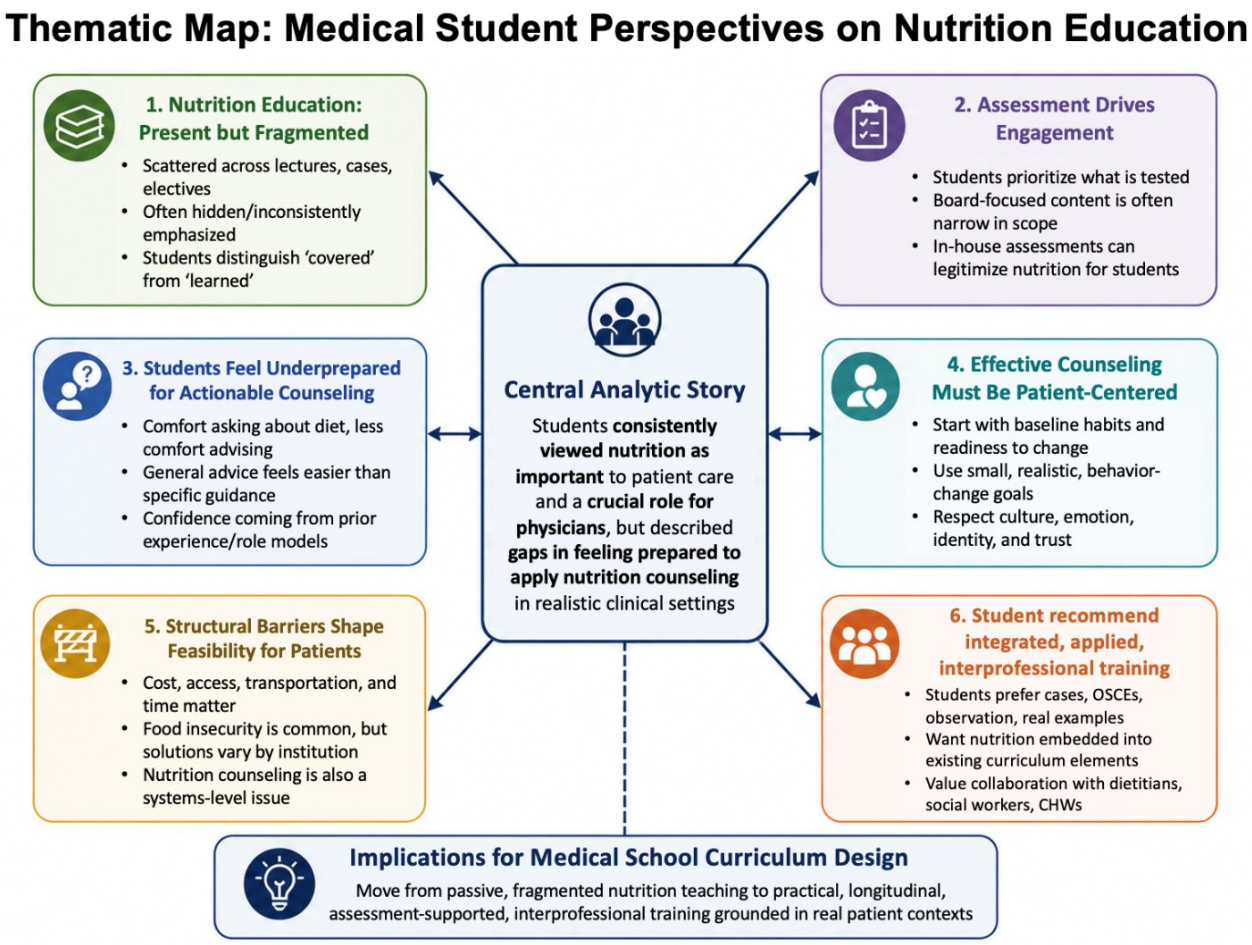
Three broad conclusions emerge:

First, students are calling for a shift from disjointed exposure to nutrition knowledge to clinical usability. They specifically request training that prepares them not only to identify nutrition-related concepts, but to talk with patients about food in ways that are specific, feasible, culturally responsive, and sensitive to real-world barriers.

Second, students are calling for a shift from isolated content to integrated competencies. They do not see nutrition as something that should be siloed in a single course or in a set of add-on modules. In contrast, they see nutrition as inherently connected to chronic disease care, prevention, communication, social determinants of health, and interprofessional collaboration.

Third, students are calling for a shift from individual counseling to systems-based practice. They recognize that nutrition care is constrained by food access, cost, transportation, insurance coverage, and community infrastructure. As a result, they want training in both counseling and resource navigation to serve all patients.

Figure 6. Thematic map representing major themes surrounding student perspectives on nutrition education. This map illustrates how student perspectives clustered around seven major themes: (1) nutrition is present but fragmented; (2) assessment drives engagement; (3) students value nutrition but feel underprepared for individualized counseling; (4) meaningful counseling must be patient-centered, culturally responsive, and feasible; (5) structural barriers shape what is realistic for patients; (6) physicians have a foundational but not exclusive role in nutrition care; and (7) centrally, students prefer applied, integrated, interprofessional learning formats.



Key Medical Student Thematic Recommendations

1. Adopt a competency-based rather than hour-only approach

Texas medical schools should align with the spirit of current federal developments by focusing on what students should be able to do, not only on how many hours of nutrition content they receive. A competency-based approach would better support durable implementation across schools with different curricular structures.

2. Define foundational physician-level nutrition competencies for all students

All graduating medical students should be able to:

- Obtain a basic diet history.
- Identify common diet-related contributors to chronic disease.
- Provide foundational evidence-based counseling for common conditions.

- Screen for food insecurity.
- Discuss nutrition in culturally respectful ways.
- Recognize limits of expertise and refer as needed.

3. Integrate nutrition into existing curricular structures

Rather than creating additional stand-alone modules, schools should embed nutrition into:

- Organ-system blocks
- Clinical skills/doctoring courses
- OSCEs and standardized patient cases
- Ambulatory and primary care rotations
- Social determinants of health activities
- Interprofessional education

4. Prioritize applied learning modalities

Students' feedback strongly supports case-based learning, counseling practice, culinary medicine, OSCEs, and other interactive approaches. These should be prioritized over passive or optional content, frequently delivered through online, asynchronous modules.

5. Treat food insecurity and resource navigation as a core curriculum

Students should learn to both identify barriers patients experience in accessing high-quality nutrition and connect patients with practical supports such as SNAP, food banks, produce programs, and local community resources.

6. Strengthen interprofessional learning

Dietitians, nutrition professionals, social workers, diabetes educators, and community health workers should be incorporated directly into medical training, both to model collaborative care and to clarify role boundaries.

7. Use assessment to legitimize nutrition education

Nutrition should appear in meaningful, formal assessments, including applied questions, OSCEs, and required clinical activities focusing on the currently available consensus on recommended core competencies.[352] Assessment should avoid pure

factual recall and instead emphasize practical counseling points and common patient conditions/requests.

8. Develop shared statewide tools to reduce burden on schools

The TNAC could help support medical schools working to implement nutrition education by sharing available resources such as:

- Culturally tailored substitution guides
- Resource-navigation templates
- Standardized OSCE cases
- Faculty development materials
- Curricular mapping tools tied to competencies

9. Continue incorporating student voices into implementation strategies

Students are uniquely positioned to identify where curriculum elements feel meaningful. Ongoing student feedback should be built into statewide and institutional evaluation efforts to help optimize the iteration of new nutritional education elements.

Summary of UME Context

The findings presented in this chapter demonstrate substantial alignment among the scientific literature, national educational initiatives, and Texas medical student perspectives. Collectively, these sources support a shift from isolated nutrition content toward competency-based approaches that emphasize clinical application, behavior change counseling, interdisciplinary collaboration (especially with registered dietitians), and integration throughout the curriculum. As Texas medical schools implement the requirements of Senate Bill 25, there is an opportunity to build upon existing institutional strengths while remaining responsive to local patient populations, community needs, and educational structures. No single curriculum model is likely to meet the needs of every institution; however, shared competencies, best practices, educational resources, and evaluation strategies may help support successful implementation across diverse settings.

TNAC Recommendations

The TNAC encourages Texas medical schools to align nutrition and metabolic health education efforts with emerging national best practices, including ongoing initiatives led by the U.S. Department of Health and Human Services, to advance nutrition

education across the healthcare workforce. Educational approaches should remain adaptable to local contexts while emphasizing core physician competencies in nutrition assessment, patient counseling, behavior change strategies, interdisciplinary collaboration, and resource navigation.

The TNAC further encourages institutions to invest in the faculty expertise, curricular infrastructure, educational resources, and community partnerships necessary to support meaningful implementation. Collaboration among Texas medical schools to share curricular resources, faculty development opportunities, assessment tools, and implementation experiences may help reduce institutional burden while accelerating progress toward preparing future physicians to address nutrition and metabolic health in clinical practice.

Graduate Medical Education

Legislative Context

Although Senate Bill 25 does not establish specific nutrition and metabolic health requirements for graduate medical education (GME), residency and fellowship training represent a critical period in the development of physician knowledge, clinical skills, and practice patterns. During GME, trainees assume increasing responsibility for patient care and frequently manage chronic conditions in which nutrition and metabolic health play an important role.

Nationally, interest in nutrition education within residency training has grown, reflecting recognition that many physicians report limited preparation to address nutrition-related concerns in clinical practice. Opportunities exist for residency and fellowship programs to incorporate nutrition and metabolic health concepts through ambulatory training, inpatient care, interdisciplinary learning experiences, quality improvement initiatives, lifestyle medicine programs, culinary medicine programs, and community-based clinical experiences.

Strengthening nutrition and metabolic health education across the continuum of medical training from undergraduate medical education through residency, fellowship, and continuing professional development may help prepare physicians to deliver evidence-based, patient-centered care throughout their careers.

Background

Nutrition education in GME has consistently been shown to be inadequate. While most medical residents believe nutrition counseling to be important, few feel prepared to

guide patients on such topics.[353] A survey of 495 program directors across internal medicine, family medicine, surgery, and anesthesiology found that only 26% offered formal GME in nutrition.[354] Studies have also shown that only 29% of medical, surgical, and obstetric interns at 6 programs felt prepared to handle clinical cases requiring nutrition knowledge.[355] Similarly, 94% of internal medicine (IM) residents believed nutrition counseling was essential, but only 14% felt adequately trained.[356] Such shortcomings in nutrition counseling confidence stem from deficient nutrition education beginning in medical school.[357] Despite the 1985 National Research Council's recommendation for a minimum of 25 hours of nutrition education for medical students, a 2015 survey shows trainees receive an average of only 19 hours throughout medical school with more than half never having taken a formal course on nutrition.[358,359] Fortunately, studies have shown that elective training in obesity, nutrition, and physical activity counseling increases both self-efficacy and positive attitude scores towards counseling for IM and obstetrics residents.[360]

Over the past few years, both state and national level policies have increased attention to address these gaps. In 2022, the U.S. House of Representatives passed Resolution 1118 calling for meaningful nutrition education for healthcare trainees.[361] In 2024, a team of nutrition experts reviewed literature and developed consensus for 36 nutrition competencies to be included in medical education.[352] In 2026, the U.S. Department of Health and Human Services (HHS) further expanded upon these competencies and called for medical schools to commit to incorporating nutrition into their curricula.[362] Similarly, Senate Bill 25 advocates for nutrition education for all levels, from primary and secondary education to higher and continuing education for health care professionals.[363] Many implementation strategies for nutrition education have been proposed, including classroom didactics, case-based learning, online modules, simulated encounters, culinary medicine workshops, service-learning, electives, specialty tracks, and integration of nutrition counseling in clinical settings.[353,364] Other strategies include expanding access to existing nutrition-focused CME programs, including specialty certifications, linking nutrition with social drivers of health, strengthening technology-based nutrition tools, and strengthening interprofessional collaboration with registered dietitian nutritionists (RDNs).[365] Barriers to implementation of nutrition education do exist, including time constraints, lack of standardized accreditation requirements, and cost concerns for both nutrition educator support and appropriate reimbursement for nutrition interventions.[353,357]

Summary of GME Approaches

The TNAC encourages Texas residency and fellowship programs, healthcare systems, and academic medical centers to explore opportunities for integrating nutrition and metabolic health education into graduate medical education in a way that is synergistic

with the other efforts described in this report and the emerging competency guidance across specialties from the Association of Graduate Medical Education (ACGME). Collaboration among educators, clinicians, registered dietitians, and community partners may help ensure that nutrition competencies introduced during medical school are reinforced and applied in clinical practice.

Continuing Medical Education (CME)

Legislative Context

Senate Bill 25 (89th Texas Legislature) recognizes the important role healthcare professionals play in translating nutrition science into patient care by establishing new continuing education requirements in nutrition and metabolic health. The legislation directs relevant licensing and regulatory bodies to incorporate nutrition and metabolic health into continuing education activities and encourages educational content informed by the recommendations of the TNAC. As these requirements are implemented, continuing medical education provides an opportunity to strengthen healthcare professionals' understanding of the relationship between dietary patterns, metabolic health, and chronic disease while enhancing their ability to support screening for nutrition risk and promote patient-centered nutrition education and behavior change guidance in clinical practice.

Background

Physician diet counseling has been demonstrated to support patient dietary behavior change.[366,367] Patients who receive nutrition-related advice from healthcare professionals more frequently report behavior change attempts,[368] such as increased consumption of fruits and vegetables,[369] reduction in fat and calorie intake,[370] and visiting a registered dietitian nutritionist (RDN).[371] These dietary behavior changes have also yielded improvements in clinical markers of chronic disease. Randomized control trials in primary care found physician diet counseling to yield modest weight loss in patients with overweight and obesity[371] and improved serum cholesterol levels in patients with diabetes.[372]

Despite the potential for improved patient outcomes, rates of diet counseling in practice are suboptimal. A national cross-sectional analysis revealed that only 21% of patients with diabetes reported receiving diet counseling from their physician.[373] Direct observation of appointments suggests these conversations may occur at even lower rates.[374,375] While patients with obesity and comorbid conditions have reported an increase in nutrition counseling from their physician,[370,376] an analysis of the National Ambulatory Medical Care Survey concluded that only 25% of patients with an obesity

diagnosis received diet counseling.[377] Poor counseling rates are mirrored among physician trainees. In a cross-sectional survey of family medicine residents, only 13.9% reported that they set a nutrition-based goal with their patients.[378]

Continuing education represents a scalable strategy for improving nutrition competency across the healthcare workforce and may help ensure that advances in nutrition and metabolic health research are translated into clinical practice for the benefit of Texans. Many strategies exist, minimizing the need for new tools, and emphasis on refinement of existing pathways likely serves as the least resource intensive-approach.[365]

Review of CME Strategies

A recent review of approaches for enhancing practicing physicians' nutrition counseling capacity in continuing medical education contexts identified four primary intervention modalities. While some approaches improved provider knowledge and confidence, significant gaps remain across all modalities in translating training into sustained practice behavior change and patient health outcomes. Findings are summarized below.

Workshops

Workshops [379-395] primarily improved knowledge, confidence, and attitudes through active learning strategies like role-playing and case studies. Studies demonstrated that culturally tailored content enhanced effectiveness, with adaptations for local dietary contexts improving caregiver recall of dietary advice. However, most interventions provided brief training (single sessions of one to four hours) without ongoing support or reinforcement, potentially explaining limited sustained practice change. Knowledge gains often diminished without reinforcement, with some studies showing declines by 15 months post-intervention. Few workshop interventions assessed patient-level outcomes. One study that incorporated office support materials alongside training demonstrated significant reductions in weight, BMI, HbA1c, and fat intake following physician-led counseling, while others showed improvements in patient recall of dietary advice and motivation for behavior change.

Screening Tools

Screening tools [396-401] designed for use in physician clinical practice provided structured patient dietary data to inform counseling but faced adoption barriers. Tools like rapid dietary screeners correlated well with comprehensive assessments and could be completed in approximately 10 minutes, but use of screening tools alone showed limited effectiveness in changing physician counseling behavior. While tools achieved

high completion and electronic health record (EHR) integration rates, they guided counseling in only a minority of visits, highlighting the gap between data collection and actionable counseling. Further, these tools standardized dietary assessments but often disrupted clinical workflows.

Practice-Based Tools

Practice-based tools [402-411] focused on workflow integration and implementation outcomes but largely failed to bridge the gap between technology and sustained practice change. Basic EHR alerts improved guideline adherence but required complementary strategies to overcome time constraints and workflow disruptions. Patient-facing interactive digital tools (e.g., "Little-by-Little") achieved learning and goal setting among patients but did not engage physicians in counseling. Patient education handouts (e.g., Food for Heart) supported patient understanding when incorporated into interventions. These findings highlight the need for physician-facing tools that integrate directly into clinical workflows. One recent clinical decision support system (Nutri) demonstrated this approach, featuring an interactive interface for collaborative goal setting during consultations, achieving high usability and increased clinician self-efficacy while combining technology with training and patient education materials.

Multimodal interventions

Multimodal interventions [412-424] combined multiple strategies to address nutrition counseling challenges comprehensively. By integrating workshops, screening tools, CDSS, patient materials, and follow-up mechanisms through mail, phone, or web-based platforms, these approaches targeted both physician-level and patient-level factors. Studies demonstrated healthier fat intake, increased fruit and vegetable consumption, and enhanced counseling practices. In one case, an intervention completed in Texas gave physicians a brief diet counseling training and then a software to support implementation and resulted in 100% usage of diet counseling in appointments, with 81% of patients reporting goal setting and 57% initiating their goal.[425] In the same intervention, primary care physicians reported diet counseling self-efficacy and competence improved. Multimodal strategies show promise in addressing systemic barriers and achieving more robust outcomes than single-modality interventions.

This brief review demonstrates that while interventions can improve physician knowledge and attitudes, significant gaps remain in achieving sustained practice change and patient health outcomes. Across all modalities, patient-level outcomes remained understudied. Few trials measured patient-level outcomes, and those that did typically assessed short-term metrics like weight loss or dietary adherence but

lacked longitudinal follow-up to assess sustainability. Few studies tracked biomarkers like HbA1c or cholesterol. These findings highlight the need for extended evaluation timelines and innovative approaches that integrate technology to support sustained behavior change. To address these limitations, future interventions should prioritize point-of-care learning models that embed nutrition counseling within clinical workflows, moving beyond knowledge transfer to actual practice implementation. Additionally, given the evolving nature of nutrition science, interventions should be designed with flexibility to incorporate updated dietary guidelines, ensuring physicians have access to current, evidence-based recommendations during patient encounters.

Goals of CME

The goal of training physicians, nurses, advanced practice providers, and other healthcare professionals in nutrition is not to equip them to fulfill the role of dietitians but to help promote collaboration and advocacy for the value of nutrition professionals. Only through this multidisciplinary collaboration rooted in improved nutrition education can patients in Texas and beyond receive essential care in the role of nourishing eating habits and healthful living for human health promotion.

Population Communication Strategies

General Principles

Effective public health communication is essential to translating nutrition science into meaningful behavior change. Even the strongest evidence-based recommendations have limited impact if they are not communicated in ways that are understandable, actionable, culturally relevant, and accessible to the populations they are intended to serve. Communication strategies should help Texans understand not only what healthy choices are, but also how to apply them within the realities of their daily lives.

Communicating health and disease is challenging. Science uses very specific words that can be hard to read, much less understand, for those with low literacy skills, such as limited reading and reading comprehension. Some people may be able to read fluently but still find their understanding of health terms (health literacy) is limited. Most of this report uses scientific language to convey complex literature reviews and scientific concepts, but this section and the Executive Summary seek to use accessible language. The TNAC encourages efforts that ensure all ages and groups can understand and implement the findings of this report.

Health information should be easy to understand, using common words when possible, and the simplest word that gets the meaning across when a common word is not available.[426] Knowing the most important messages you want to relay is an essential part of the process. Keep the number of health messages you talk about at one time to just a few. Messages should also be short, concise, memorable, focused, and consistent. Messages should align with each other. That is, one message should not contradict another one. They should also be relevant to the people you want the message to reach and be tailored to their needs.

When you communicate, use language like you would when talking to someone in a conversation.[426] This helps everyone understand without feeling as though they are getting a lecture. Using common words, not medical jargon, is also important. If you need to use a medical or scientific word, be sure to define it first. Finally, repeat important messages that you want people to understand and remember.

When you make a document about a health topic for people to read, put "like" messages together under a heading. That way, all the messages that are about the same idea are all in one place. For people with lower reading skills, use words with one or two syllables when you can. Present information in a clear, organized format using concise paragraphs, headings, visuals, and bullet points when appropriate. Using short,

easy-to-read sentences is also important. Using white space helps break things into sections that people can read one part at a time. For those who struggle to read, a page packed with words can be a barrier to even starting to read. Having white space makes it easier to get started.

Images that show what to do also help. Not everyone can read. Even those that read well find that pictures help make the point. However, for those who are not sighted, all pictures should have clear "alternative text" descriptions that tell what the picture shows so that those with screen readers can clearly understand the same messages. Color contrast should also be large enough that those with poor vision can read and understand the message or image.

When you think about the order for health information, make the most important piece of information first on the page. Be brief. Then add supporting information under the main point using bulleted lists and images to make the message clear. Be sure to repeat the main points at the end and use white space in between.

Considering your audience is important. This means being polite and thinking about how someone who is not like you might read the message. This means not blaming someone for their health problems or for being poor just by using poorly worded language. Also, use person-first language (e.g. person with diabetes instead of "a diabetic").

Effective communication extends beyond readability. Messages are more likely to be received and acted upon when they are delivered by trusted messengers, reflect the cultural traditions and lived experiences of the intended audience, and acknowledge real-world considerations such as time, cost, food access, and cooking skills. The Five Filters paired with the dietary guidelines help organize this approach. Public health communication should empower rather than shame individuals and families, emphasizing practical steps that can be adapted to different circumstances.

The framing of health messages has also been shown to have an impact on health outcomes.[427] The framing refers to whether the message seems positive (if you do this, this great thing will happen) or if it seems negative (if you don't do this, this bad thing will happen).[428] Gain-framed messages are positive messages that show the benefits of taking a certain action. Loss-framed messaging emphasizes the disadvantages that may result from a certain action. In some health outcome studies, gain-framed messaging was found to be superior, especially when explaining to people how to prevent health problems.[429] People may respond with more excitement to messages about things that they can do to prevent health problems rather than a warning of a negative consequence.

Interestingly, culture may play a part in what type of message results in the most intention to change. In a study promoting colorectal cancer screening, white Americans were more likely to be screened for colorectal cancer with loss-framed messages.[430] Black Americans were more receptive to gain-framed messages. This shows that culturally framed messages are important to promote change. When talking about food, using examples of foods that the people in the culture often prefer to eat and using pictures of those foods can help people understand how to take action in their own lives.

Public health messages may be delivered through a variety of channels including healthcare settings, schools, community organizations, faith-based institutions, social media, digital platforms, and traditional media. Consistent messaging across multiple trusted channels can reinforce key concepts and increase reach across diverse populations.

Summary of Public Health Communication Principles

- Use plain, audience-centered language.
- Focus on a small number of clear, actionable messages.
- Ensure communications are culturally relevant and accessible to diverse populations.
- Utilize multiple trusted messengers and communication channels.
- Incorporate visual and digital communication strategies to improve understanding and engagement.
- Test materials with intended audiences whenever possible.

Effective nutrition communication should move beyond simply providing information and instead support individuals and families in making realistic, sustainable changes within their own cultural, economic, and personal contexts.

Research Gaps and Priorities

Nutrition research has historically been challenged by limitations in dietary assessment methods, inconsistent outcome measures, and the long-time horizon over which many nutrition-related diseases develop. Advancing nutrition and metabolic health research will require improved approaches to measuring dietary intake, evaluating dietary patterns, and assessing health outcomes across diverse populations.

Standardized dietary assessment methods, validated biomarkers of dietary exposure, and integration of nutrition-related measures into clinical and public health data systems can strengthen the quality, comparability, and applicability of nutrition research. These approaches may improve understanding of the relationships among dietary patterns, metabolic health, chronic disease risk, and health outcomes while supporting the development of more effective prevention and intervention strategies.

Particular attention should be given to strengthening methods for studying dietary patterns and food processing exposures, including UPF, within real-world community and healthcare settings. Standardized nutrition measurement systems provide a scalable framework for population-level analysis.[431] By generating longitudinal, high-resolution dietary intake data, these approaches can support evaluation of dietary risk patterns and inform public health strategies. Establishing structured, standardized nutrition data infrastructure is a critical next step in advancing research methodology and supporting the development of more actionable, data-driven nutrition policy and chronic disease prevention strategies.

The TNAC identified several areas where additional research may help inform future policy, clinical practice, and public health initiatives:

- Mechanistic research to better understand biological pathways linking dietary patterns, food processing, metabolic dysfunction, and chronic disease.
- Texas-specific nutrition and UPF surveillance to better characterize dietary patterns, disparities, and health outcomes within the state's diverse populations.
- Implementation science to identify effective and scalable strategies for improving diet quality across healthcare, community, educational, and workplace settings.
- Long-term health outcomes research examining the impact of dietary patterns and reductions in UPF consumption on chronic disease incidence, quality of life, and healthcare utilization.

- Safety of commonly available "wellness" products that are ultra-processed, including those designed for meal replacement
- Economic analyses evaluating the cost-effectiveness and return on investment of nutrition-related interventions.
- Population-specific research examining differential impacts of dietary patterns across age groups, geographic regions, socioeconomic circumstances, and cultural communities.
- Food safety and food systems research, including evaluation of additives, food packaging risks, ingredient interactions, and cumulative dietary exposures.
- Commercial determinants of health research examining how food environments, marketing, pricing, and availability influence dietary choices and health outcomes.
- Emerging areas of nutrition science, including reproductive health, maternal and child health, cognitive health, healthy aging, microbiome relationships, epigenetic effects, and precision nutrition approaches (including nutrigenomics and metabolomics).

The TNAC encourages sustained state investment in nutrition and metabolic health research, including support for interdisciplinary collaborations, community-engaged research, implementation science, and data infrastructure. The development of this report brought together experts from academic institutions, healthcare systems, public health organizations, and community partners across Texas, demonstrating the state's capacity to lead impactful research initiatives. Continued investment in these efforts can help generate Texas-specific evidence, accelerate innovation, and inform policies and programs that improve health outcomes for current and future generations of Texans.

Concluding Recommendations

Public Health Communication

Effective public health communication should empower Texans with practical, evidence-based information while recognizing that nutrition decisions occur within the realities of daily life. The TNAC recommends a **"progress, not perfection"** approach that encourages meaningful, sustainable improvements rather than rigid rules or unattainable ideals. Individuals and families differ in their health needs, cultural traditions, food access, budgets, cooking skills, and personal preferences, making flexibility essential to successful implementation.

The recommendations in this section translate current scientific evidence into practical communication strategies that support informed individual decision-making without being overly prescriptive. By emphasizing achievable changes, acknowledging real-world barriers, and promoting multiple pathways toward healthier eating patterns, Texas can foster lasting improvements in nutrition and health while respecting the diversity of its communities.

Promote Clear, Consistent, and Actionable Messaging

The TNAC encourages the development and dissemination of nutrition communications that use plain language, emphasize actionable behaviors, and are appropriate for varying levels of health literacy. Communications should focus on practical strategies (such as recipe recommendations, food budgeting strategies, and culinary approaches) that individuals and families can implement within their daily lives, rather than solely providing information about nutrients or dietary patterns. Messages should be framed positively, emphasize achievable steps, and avoid stigmatizing language.

Ensure Cultural Relevance and Real-World Applicability

Texas is home to diverse populations with unique cultural traditions, food preferences, household structures, and resource constraints. The TNAC recommends that public health nutrition communications be developed with consideration for common food practices, language needs, affordability, food access, cooking skills, and other factors that influence dietary choices. Nutrition guidance should recognize that there are multiple pathways to achieving healthy dietary patterns and should support adaptation to individual and family circumstances.

Utilize Trusted Messengers and Community Partnerships

The TNAC encourages collaboration with healthcare professionals, registered dietitians, educators, community organizations, faith-based organizations, agricultural partners, and local leaders to disseminate nutrition information. Trusted messengers can increase message credibility, improve engagement, and help tailor communications to local community needs. Community engagement should be incorporated into the development, implementation, and evaluation of public health communication efforts.

Leverage Multiple Communication Channels

The TNAC recommends use of diverse communication platforms, including healthcare settings, schools, worksites, community organizations, digital media, social media, and traditional media outlets. Utilizing multiple channels can increase reach and reinforce consistent evidence-based nutrition messages across populations and settings.

Invest in Evaluation and Continuous Improvement

The TNAC encourages evaluation of public health communication initiatives to assess reach, comprehension, trust, engagement, and behavioral outcomes. Audience testing and feedback should be incorporated whenever feasible to ensure communication remains understandable, relevant, and responsive to the needs of Texans. Evaluation findings should be used to refine and strengthen future communication efforts.

Strengthen Coordination Across State and Local Stakeholders

The TNAC recommends coordination among state agencies, healthcare systems, educational institutions, public health organizations, community-based organizations, and agricultural stakeholders to promote consistent, evidence-based nutrition messaging. Collaborative efforts can reduce conflicting information, maximize resource efficiency, and improve the overall effectiveness of nutrition initiatives throughout Texas.

Communicate Nutrition Through a Practical, Whole-Person Lens

The TNAC encourages communication strategies that acknowledge the realities influencing food choices, including food access, affordability, cultural traditions, health conditions, household needs, personal preferences, skills, and time constraints. Public

messaging should empower Texans to identify realistic and sustainable approaches to healthy eating rather than promoting a single prescriptive approach. Recognizing these real-world considerations may improve engagement, foster trust, and support long-term dietary behavior change.

Food Environment and Systems

While nutrition education helps individuals understand healthy dietary patterns, food environments influence whether those choices are practical, affordable, and accessible within everyday life. Individual food choices are shaped by a range of factors including food availability, affordability, marketing, transportation, institutional policies, and community resources. Food systems encompass the production, processing, distribution, marketing, retail sale, preparation, and consumption of food. Together, food environments and food systems help shape dietary patterns and health outcomes across Texas. Policies and partnerships that support healthy food environments may help make nutritious choices easier and more achievable for Texans across diverse communities and life circumstances.

Information Environment

Consumers encounter nutrition information through food labels, advertising, digital media, healthcare professionals, schools, and community organizations. The quality, clarity, and consistency of this information can influence food purchasing decisions and dietary behaviors.

Nutrition labeling and consumer information strategies are intended to support informed decision-making by providing accessible information about food products. In Texas, Senate Bill 25 (89th Legislature) established new food labeling requirements while also emphasizing nutrition education and health literacy as complementary approaches to improving public health. As nutrition labeling policies continue to evolve, implementation efforts should prioritize clarity, transparency, consumer understanding, and ongoing evaluation. Information should be evidence-based, communicated in plain language whenever possible, and designed to help individuals apply nutrition information in real-world purchasing decisions.

Food and beverage marketing also influence consumer awareness, preferences, and purchasing behaviors. Children and adolescents may be particularly susceptible to marketing messages because of ongoing cognitive development and extensive exposure through digital and social media platforms. Efforts to improve the information environment may include reducing misleading nutrition claims, increasing

transparency, and encouraging responsible marketing practices that support informed consumer choice while remaining practical and feasible for stakeholders.

Access and Community Food Systems

Access to nutritious foods is influenced by more than individual knowledge or motivation. Factors such as food availability, affordability, transportation, geographic location, and community resources can significantly shape dietary choices.

Nutrition assistance programs, including SNAP, WIC, school meal programs, summer nutrition programs, and community food assistance initiatives, play an important role in reducing food insecurity and supporting access to nutritious foods. Opportunities to strengthen these programs include improving participation, increasing awareness of available resources, enhancing nutrition and culinary education, supporting culturally relevant food options, and evaluating approaches that encourage consumption of nutrient-dense foods.

Texas includes diverse urban, suburban, and rural communities with unique food access challenges and opportunities. Community food systems, including food banks and other charitable food organizations, farmers markets, local retailers, Farm Fresh initiatives and similar agricultural partnerships, can help connect consumers with nutritious foods while supporting Texas agriculture and local economies. Strategic partnerships among healthcare systems, schools, community organizations, food assistance providers, and agricultural stakeholders may help strengthen food security and improve health outcomes.

Particular attention should be given to rural communities, where transportation barriers, healthcare workforce shortages, and limited food access may compound nutrition-related health disparities. Strengthening local food infrastructure and distribution networks may support both community health and economic development.

Institutional Food Environments

Institutions such as schools, childcare centers, healthcare facilities, universities, workplaces, correctional facilities, and government agencies serve millions of meals each year and play an important role in shaping dietary patterns.

Food procurement, menu planning, food preparation practices, and food service environments can influence both food availability and food choices. Institutional policies may support nutritious, appealing, culturally relevant, and affordable meal options while accommodating diverse dietary needs and preferences. Opportunities

also exist to integrate nutrition education, culinary skills development, and behavior change strategies into institutional settings.

Because institutions purchase food at scale, they can influence both population health and broader food systems through procurement decisions. These efforts may also contribute to improved workforce health, productivity, and long-term healthcare cost savings.

Food System Partnerships and Innovation

Improving food environments requires collaboration across sectors. Agriculture, healthcare, education, food retailers, manufacturers, distributors, community organizations, and government agencies all play important roles in shaping the foods available to Texans.

Programs highlighted throughout this report, including Farm Fresh initiatives, local food procurement efforts, Food as Medicine programs, nutrition assistance programs, and other community-based interventions, demonstrate the potential value of coordinated partnerships. Texas is uniquely positioned to strengthen connections among agricultural producers, healthcare systems, schools, community organizations, and food assistance providers in ways that support both public health and economic development.

Continued innovation and evaluation are needed to identify effective strategies for improving dietary quality, reducing food insecurity, and preventing chronic disease. Areas for future exploration may include community-based Food as Medicine models, local procurement strategies, healthcare-community partnerships, and research examining the relationship between agricultural practices, food quality, and health outcomes. Evaluation should remain a central component of these efforts to ensure that resources are directed toward approaches that demonstrate meaningful impact.

Summary Recommendations for Food Environment and Systems

In addition to policies and other frameworks, the TNAC recommends consideration of state funding strategies to promote innovation in the following areas.

Strengthen Access to Nutritious Foods Across Texas Communities

Improve food availability, affordability, and accessibility through nutrition assistance programs, community food systems, and local partnerships.

Support Institutional Food Environments

Encourage schools, healthcare systems, worksites, and other institutions to align food procurement and service practices with evidence-based nutrition principles, ideally incentivizing and funding innovation strategies.

Advance Food Security and Food as Medicine Initiatives

Support evidence-based approaches that integrate nutrition into chronic disease prevention and management while addressing food insecurity.

Promote Evidence-Based Consumer Information

Evaluate and refine labeling, communication, and consumer information strategies to improve nutrition literacy and informed decision-making, including impact evaluation.

Foster Cross-Sector Partnerships and Innovation

Encourage collaboration among agriculture, healthcare, education, public health, food industry, and community organizations while supporting research and evaluation of emerging food system strategies.

Appendix A. Committee Member Biographies

The TNAC was established by Senate Bill 25 of the 89th Texas Legislature and is composed of seven members appointed by Governor Greg Abbott in December 2025. The Committee was intentionally designed to bring together diverse perspectives spanning medicine, nutrition, nursing, agriculture, business, and both rural and urban communities to provide independent, evidence-based guidance on nutrition and metabolic health for Texans. In accordance with Senate Bill 25, committee members do not have conflicts of interest with food, beverage, pharmaceutical, or dietary supplement companies. Brief biographies of the inaugural committee members are provided below in alphabetical order.

Jaclyn Albin

Jaclyn Lewis Albin, MD, CCMS, DipABLM, is an Associate Professor of Internal Medicine, Pediatrics, and Public Health at The University of Texas Southwestern Medical Center (UTSW) in Dallas, Texas. She is a board-certified physician in Internal Medicine, Pediatrics, and Lifestyle Medicine, a Certified Culinary Medicine Specialist, and has dedicated her career to advancing nutrition education, culinary medicine, and Food is Medicine initiatives across Texas and nationally.

Dr. Albin served for 11 years as the founding Associate Program Director of the combined Internal Medicine/Pediatrics Residency Program at UTSW. She is the inaugural Director of UTSW's Culinary Medicine Program and Medical Director of Food as Medicine Innovation at Parkland Health, where she leads the integration of evidence-based nutrition into medical education, clinical care, research, and community partnerships. Her work has pioneered innovative models for integrating nutrition into undergraduate and graduate medical education, while also advancing sustainable clinical programs that improve patient and community health.

Nationally, Dr. Albin serves as incoming President of the American College of Culinary Medicine and previously chaired its Graduate Medical Education Committee, leading efforts to establish best practices for culinary medicine education across residency and fellowship training. She also serves on the Advisory Board of the Teaching Kitchen Collaborative, and her scholarship and invited presentations have helped advance nutrition education and Food as Medicine implementation across health systems.

Dr. Albin serves as the pediatrician member and inaugural Chair of the TNAC.

Natalie Bachynsky

Natalie Bachynsky, PhD, FNP-C, RN of Lovelady is a family nurse practitioner and owner of Houston County Family Medical Clinic and Chester Family Clinic. Dr. Bachynsky earned a Doctor of Philosophy in Nursing Science and Post-Masters Family Nurse Practitioner certificate from Texas Woman's University (2017; 2014) and a Bachelors and Master's Degree in Nursing from the University of Texas Medical Branch in Galveston (1998; 2008). Dr. Bachynsky has dedicated her professional career to patient advocacy and improving care for underserved populations.

In addition to serving as rural member on the TNAC, Dr. Bachynsky is also a member of the Texas Nurse Practitioners, the University of Texas Medical Branch (UTMB) School of Nursing Alumni Association, The Menopause Society, and the American Association of Nurse Practitioners. She is the medical advisor of the Michelle Lynn Holsey Foundation, a board member for Houston Country Career Women and a past member for the Texas A&M Rural Medicine Advisory Board.

Prior to serving as a nurse practitioner in rural East Texas, Dr. Bachynsky was an Assistant Professor at the University of Texas Medical Branch for many years. She continues to serve as a preceptor for nursing, nurse practitioner, medical and pharmacy students in effort to expose students to the diverse needs of rural Texans and the fulfillment of a career centered on service and collaborative relationships.

Kathleen Davis

Kathleen Davis, PhD, RDN, LD is an Associate Professor and the Dietetic Internship Director at Texas Woman's University (TWU) in Denton, Texas. She has been a Registered Dietitian Nutritionist (RDN) serving Texans from her hometown of Denton for over 20 years. She has been teaching nutrition full-time at Texas universities for over 15 years. She trains 16-18 new RDNs every year in her role as internship director at TWU and loves preparing the next generation of RDNs and researchers to serve their communities.

Her research focuses on how to improve the health of Texans by improving nutrition literacy and food skills so that Texans know what healthy foods are, how to prepare them, and feel confident that they can make healthy choices. Dr. Davis has published multiple articles on improving the nutrition and food literacy of children, parents, and college students, as well as articles on college student food insecurity and the college campus food environment.

Dr. Davis has won several awards for teaching, including the Outstanding Nutrition Education Award from the Texas Academy of Nutrition and Dietetics in 2021. She also won TWU's Distinction in Research award in 2025 and the Excellence in Reviewing Award from the Journal of Nutrition Education and Behavior in 2022. In her patient care, teaching, and research, she focuses on how to improve the lives of Texans through nutrition education, improving food skills, and improving access to healthy foods.

Sid Miller

An eighth-generation farmer and rancher, Sid Miller is the 12th Commissioner of the Texas Department of Agriculture (TDA). Since taking office in 2015, Commissioner Miller has brought real, common-sense reform to TDA and has devoted his time to promoting Texas agriculture, rural communities, and the great state of Texas. First elected in November 2014, Commissioner Miller was re-elected to a third term as Agriculture Commissioner in 2022, receiving 4.2 million votes – a state record for this office. He will be the first to serve more than two terms as Agriculture Commissioner in over 45 years.

Miller quickly earned his reputation as a staunch defender of Texas agriculture, constitutional freedoms, and individual liberties for all Texans. He is the state's strongest advocate for Texas agriculture, Texas-grown products, and Texas-owned businesses.

Commissioner Miller is a businessman who breeds and trains his own American Quarter Horses. In his spare time, he is a recognized rodeo cowboy with 26 world championship titles. He and his wife, Debra, have been married for 48 years. They have two sons, two daughters-in-law and five grandchildren. They are active members of the Cowboy Church of Erath County, where Commissioner Miller also serves as an elder.

Padmaja Patel

Padmaja Patel is a board-certified internist specializing in lifestyle medicine and healthcare transformation strategies. She is the President of the American College of Lifestyle Medicine (ACLM) and Chief Medical Officer of Nudj Health, an ACLM-certified Lifestyle Treatment Program. In addition, Dr. Patel serves as the President of Midland Quality Alliance and the Chair of Quality Committee, an Accountable Care Organization Realizing Equity, Access, and Community Health (ACO-REACH) located in Midland, TX, and a member of the Texas Medical Board's committee on Alternative Payment Models. She is also a member of the National Quality Forum's 2024 Healthcare Professional

Stakeholder Advisory Council and the Endorsement and Maintenance Committee of the Partnership for Quality Measurement. Dr. Patel serves on the Whole Person workgroup at the Primary Care Collaborative and is the founding Chair of ACLM's Clinical Practice and Quality Committee. Dr. Patel is appointed by the Governor of Texas to serve on the Texas Nutrition Advisory Committee.

Dr. Patel is a pioneer in the field of Lifestyle Medicine (LM) and has developed innovative care delivery models. Her work includes designing an office-based intensive cardiac rehabilitation program for physicians and serving as medical director of the Lifestyle Medicine Center at Midland Health. Dr. Patel has successfully delivered LM-based intense therapeutic lifestyle change programs for chronic disease remission in both in-person and virtual settings. She is a strong advocate for LM integration within health systems across the patient care continuum and in employee and population health. Her efforts to integrate lifestyle medicine into employee health have resulted in significant cost savings. She has also held the position of lifestyle medicine Medical Director at Wellvana, a national value-based healthcare organization and as Vice President of the World Lifestyle Medicine Organization. During her time with Wellvana, Dr. Patel designed LM care delivery models to integrate LM within ACOs and Medicare Advantage. Her contributions have been instrumental in advancing the integration of LM into healthcare systems and improving patient outcomes.

Dr. Patel has been awarded the prestigious title of Fellow of ACLM in recognition of her remarkable contributions to the field of Lifestyle Medicine. Additionally, she has been honored with the 2023 American Medical Women’s Association Inspire Award, which acknowledges her as a source of inspiration for others through her dedication to healthcare, compassionate treatment of patients, leadership, advocacy, and community service. Dr. Patel is a Certified Lifestyle Medicine Intensivist, a recognition given to those who have successfully used Lifestyle Medicine as a therapeutic intervention to prevent, treat, and even reverse chronic diseases in individuals, populations, and communities. She is also a co-founder of Healthy City, a non-profit organization aimed at raising awareness of the benefits of plant-based nutrition and lifestyle medicine within her community.

Cheryl Sew Hoy

Cheryl Sew Hoy is founder and CEO of Tiny Health, the leading precision microbiome company redefining proactive care through clinical-grade gut and vaginal microbiome testing. The Tiny Health platform powers personalized, functional microbiome insights – from Butyrate capacity, Urolithin A potential to GABA capacity – and supports +150,000 people and +5,000 providers, from the first 1,000 days to the last.

Through its Powered by Tiny model, Tiny Health integrates into health systems, precision medicine and longevity clinics, and wellness brands including Mayo's Longevity & Exec Clinic, Superpower, and LifespanMD.

In September 2025, the company published a landmark randomized control trial on infants, showing an 83% reduced odds of atopic conditions using Tiny Health's platform. Launched in 2022 and born out of her desire to take control of her own daughter's chronic condition, Cheryl developed the first at-home gut microbiome test for moms and babies, using shotgun metagenomics – now expanded across the full lifespan, offering advanced testing for chronic conditions, performance, longevity, and overall health.

A Cornell alum, serial entrepreneur, TIME's 2017 Person of the Year, and 2026 Inc. 500 Female Founder, Cheryl is on a mission to reverse and prevent chronic conditions.

Ann Shippy

Ann Shippy, MD, MS, IFMCP, of Austin is a board-certified internist, certified functional medicine practitioner, and author specializing in the care of patients with complex chronic illness, with particular expertise in nutrition, environmental health, and epigenetics. She is the founder and medical director of Ann Shippy MD and the founder of Every Baby Well and Every Life Well. For more than two decades, Dr. Shippy has dedicated her career to identifying and addressing the underlying causes of chronic disease and translating emerging science into practical strategies for prevention and improved health.

Dr. Shippy's clinical, scholarly, and policy interests include the ways nutrition, environmental exposures, metabolic health, and lifestyle influence gene expression and health across the lifespan. Her work addresses mold and mycotoxin exposure, chemical and heavy-metal burden, chronic inflammation, mitochondrial function, and the microbiome. She also has a particular interest in preconception health, including the nutritional, metabolic, and environmental preparation of both parents before pregnancy and its implications for fertility, pregnancy outcomes, childhood development, and intergenerational health.

Dr. Shippy is the author of multiple books, most recently The Preconception Revolution: A Science-Backed Path to Fertility and Generational Health. She contributed a chapter to the Textbook of Natural Medicine and has published peer-reviewed work on mold toxicity. Her TEDx talk, Epigenetics: Our Genes Alone Are Not Our Destiny, explores why genetic susceptibility does not determine health outcomes. She is a frequent voice in national media and speaks regularly to clinical, professional,

and public audiences on nutrition, environmental health, epigenetics, chronic disease, and preconception care. Before entering medicine, Dr. Shippy spent a decade as a chemical engineer and manager at IBM. Her engineering background continues to inform her systems-based approach to complex illness, scientific evidence, and public health policy.

Dr. Shippy holds the functional medicine physician seat on the TNAC and serves as its inaugural Vice Chair.

Appendix B. Subject Matter Expert Contributors

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Maha Almohammad	PhD, MS	Research Scientist, Center for Healthy Communities, UTHealth Houston School of Public Health, Department of Neurology, McGovern Medical School, Houston Texas	Boston University School of Medicine Master's in Nutrition and Biometabolism; UTHealth Houston School of Public Health PhD in Epidemiology; expertise in brain health	Led the collaborative literature review and associated chapter summary for Brain Health and dietary patterns
Daphene Altema-Johnson	MPH, MBA, RDN, LD	Senior Program Officer, Johns Hopkins Center for a Livable Future; Adjunct Faculty, Howard University College of Nursing and Allied Health Sciences; Founder, Rooted Strategies Consulting	Public health, business, and nursing degrees; specializes in Food as Medicine health promotion strategies; public health nutrition	Contributed to team working on literature review and associated chapter summary for Brain Health and dietary patterns
Kritishma Aryal	MA	PhD student at TWU	Bioactive compounds, Research, Cell culture	Data extraction, general assistance

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Lisa Aschenberg	MS, PhD student	PhD student at TWU	Bioactive compounds, research, nutrition education	Data extraction, general assistance
Karen Beathard	PhD, RND, LD	Instructional Professor, Associate Head for Undergraduate Programs, Texas A&M Dept Nutrition	Texas A&M BS and PhD, masters in nutrition and dietetics TWU, trained at VA in Houston, member and leader in many nutrition and dietetics societies; nutrition education	Collaborative review of the current Texas nutrition education landscape and development of a resource list of free or low cost non-profit nutrition education tools for K-12 educators
Kishore Botla	Medical student, BS	Medical student at UT Southwestern	Current medical student at UT Southwestern Medical School; B.S. in Nutrition from The University of Texas Austin. Prior experience includes undergraduate and medical school teaching, community-based free clinic leadership, and clinical and translational research focused on nutrition, chronic disease, and hepatology	Organized qualitative interviews of medical students across Texas for input on medical school nutrition curricular strategy; created report and thematic analysis
Marissa Burgermaster	PhD, MA	Assistant Professor, Department of Nutritional Sciences and Dept Population Health at UT Austin and Dell Medical School	PhD in behavioral nutrition and a post-doctoral master's in biomedical informatics, both from Columbia University. Her research applies biomedical informatics methods; runs the Burgermaster Lab at UT, also studies UPF, nutrition education and interventions	Detailed medical professional nutrition education evidence summary and resources, including UME to CME

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Kelly Calhoun	MS, PhD student	PhD student at TWU	Efficient dietitian-eligible with 10 years of work experience. Aiming to leverage a proven knowledge of program development, training, and lesson planning skills	Data extraction
Jelina Castillo	MD, MPH, MEd	Adolescent Medicine Fellow, Baylor College of Medicine	Adolescent weight management and nutrition, pediatrics	Guideline and graphic feedback
Felicia Ceasar-White	M.Ed.	Manager of K–12 Health and Physical Education for Houston Independent School District (HISD)	She holds a Bachelor of Science in Physical Education from Texas Southern University, a Master of Education in Educational Leadership from Prairie View A&M University and a Master of Education; longtime advocate for kids' academic success and health in TX	Contributed content for primary school nutrition education section
Batul Daginawala	MS	PhD Candidate, TWU, Nutrition	Dietetics/human nutrition, sports nutrition, adult nutrition, nutrition for metabolic and cardiovascular health	Evidence Review

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Jaimie Davis	PhD, RD	Full professor in Nutrition; Interim Director, School of Human Ecology at UT Austin	BS in Nutrition at UT Austin, became dietitian in Austin, PhD in Nutrition from UT Austin; prolific researcher with experience in physical activity and nutrition interventions for metabolic chronic conditions, especially T2DM; school nutrition ed and gardens	Supported recruitment of many nutrition expert SMEs; contributed content about her team's work and available resources on school nutrition and gardens for health
Emmy Durand	MPH, RD, SNS	Assistant Director, Customer Engagement, Cypress-Fairbanks ISD nutrition services	MPH Dietitian, 18 years experience planning school lunch; school nutrition	Organized contribution for school nutrition director perspectives on ways to meaningful integrate nutrition education with current workflows and examples of innovations and best practices
Hawley Evilsizer	RDN	Founder and CEO @ Let's Love Food Again | Nutrition and Health Strategy (formerly managing the Beef Council)	Registered Dietitian, public health nutrition, nutrition education, beef	Collaborative review of the current Texas nutrition education landscape and development of a resource list of free or low cost non-profit nutrition education tools for K-12 educators
Jane Foster	PhD	Professor, UTSW Center for Depression Research and Clinical Care (CDRC), Division of General Psychiatry	Many Canadian universities, research, PhD from U Toronto in neuroscience, has worked at UT Southwestern for years; microbiome, biomedical translational research, DNA and RNA research in mice, gut-brain axis	Content review and expertise describing the impact of UPF on microbiome

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Sera Gonzalez	MPH Student	MPH Student at the UTSW OSPH, studying health systems economics and policy	Has a degree in journalism and biology and is studying public health for her MPH; has a former career in journalism and communication; regularly volunteers with UTSW Culinary Medicine and is in a student leadership role, also working on several UTSW CulMed community health projects	Report reference management and editorial review
Angie Griffin	Doctoral degree	Assistant Professor, DPD Director at TWU	Clinical Nutrition, Food Service Systems	Guideline and graphic feedback
Keally Haushalter	PhD Candidate	PhD candidate at UT Austin in Nutrition	PhD in Nutrition from UT Austin (candidate). Experience with FI and diabetes research, biostats, UPF	Contributor to literature review for metabolic health and dietary patterns and associated chapter
Deanna Hoelscher	PhD, RDN, LD, CNS, FISBNPA	John P. McGovern Professor in Health Promotion and Austin Regional Dean, Health Promotion & Behavioral Sciences; director of Dell Center for Healthy Living	Member of the national 2025-2030 Dietary Guidelines for Americans Committee; expertise in nutrition and public health, state and national voice	Reviewed the dietary guidelines background section, especially focused on input on the federal DGA summary as a member of the national Dietary Guidelines Advisory Committee

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Erin Hudson	JD, PhD	PhD Candidate at UT Austin in Nutrition (spring 2026 grad)	Recently completed PhD in Nutrition at UT Austin. Extensive experience with UPF studying effects in different populations. UPF in diet and metabolic health expertise	Input across numerous domains including shared dissertation resources to inform defining UPF; co-lead of metabolic health literature review and associated chapter; dietary guidelines review
Jemima John	PhD, MPH	Assistant Professor Non-Tenure Research UTHealth Houston School of Public Health, Epidemiology	MPH in Epidemiology from Texas A&M University; PhD in Epidemiology from the UTHealth School of Public Health. Dr. John's research examines key social determinants of health that contribute to racial/ethnic disparities in food insecurity, physical activity, and related chronic conditions and uses multilevel, interprofessional strategies (e.g., medical-legal partnerships) to address social needs in underserved communities	Expert input on application of dietary guidelines across diverse populations and public health messaging approaches across sectors, including cross-cutting analysis of commonalities and distinct intervention approaches among dietary guidelines
Alice Kirk	MPH	Senior Extension Program Specialist-Child & School Health, AgriLife Family and Community health	Public health, nutrition education, community nutrition, school health, nutrition policy	Collaborative review of the current Texas nutrition education landscape and development of a resource list of free or low cost non-profit nutrition education tools for K-12 educators

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Rashmi Kudesia	MD, MSc, FACOG	Assistant Clinical Professor of Reproductive Endocrinology & Infertility, Houston Methodist Hospital; Director of Patient Education & Sugar Land Site Director, CCRM Fertility Houston	Board-certified specialist in reproductive endocrinology and infertility, obstetrics and gynecology, and lifestyle medicine; UPF and reproductive health, preconception, pregnancy	Led literature review on UPF and reproductive health
Anne Larson	RN, MSN	Founder & CEO, Nutrak Health	Clinical Nutrition, Nursing Informatics, Nutrition Data Measurement, Food as Medicine; nursing nutrition education and biomarkers/research consistency in nutrition	Recommendations and resources on nursing nutrition education opportunities and importance of standardized biomarkers as nutrition measures for future research directions
Monique LeMieux	PhD	Associate Professor at TWU	Omega-3s, Obesity, PCOS, Lipids, Adipose Tissue	Data extraction
Jennifer Lengyel	MS, RDN, LDN	Founder and Principal Manager, WellRooted Strategies; Former Senior Nutrition Specialist and Child Nutrition and Farm to School Expert for the Texas Department of Agriculture.	Registered Dietitian, nutrition education, community nutrition, school health, nutrition policy	Collaborative review of the current Texas nutrition education landscape and development of a resource list of free or low cost non-profit nutrition education tools for K-12 educators; Guideline and graphic feedback

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Chelsea Liu	PhD, MHS	Assistant professor (tenure-track) of Epidemiology; UTHealth Houston SPH, Brownsville regional campus, department of Epidemiology	Harvard PhD in population health sciences (epidemiology track), postdoc GW Milken; social epidemiology, older adults, race and racism in health; caregiving, dementia, chronic disease, social epi, race-based health disparities	Contributed content including literature review for older adults/dementia, caregiving, structural barriers to healthy food access for older adults
Vinuthna Mallampaty	BSA	Research Intern, Center for Healthy Communities at UTHealth Houston; Honors Neuroscience Graduate, The University of Texas at Austin, Texas	Neuroscience Research, Clinical Research and Evidence Synthesis, Community Health Engagement, Project Management.	Contributed to team working on literature review and associated chapter summary for Brain Health and dietary patterns
Lorena Macias Navarro	PhD Candidate	PhD candidate in health promotion, UTHealth Houston SPH	PHD candidate in Health Promotion/Behavioral Sciences at UTHealth, comes with a very strong policy background in nutrition in Mexico, trained in culinary medicine and has spoken at TKC	Led the literature review and associated chapter for GI diseases and dietary pattern
Bella Mei	Dietetics student	Dietetics student, in the UT Austin nutrition research labs	Dietetics student UT; prevention research lab, UPF, eating disorders research	Contributor to literature review for metabolic health and dietary patterns and associated chapter.

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Derek Miketinas	PhD, RDN	Associate Professor, TWU, Nutrition	Human Nutrition and Dietetics, Applied Statistics, Dietary Assessment and Evaluation	Evidence Review
Munachi Okpala	DNP, PhD, MBA, MSN, APRN	Department of Neurology, McGovern Medical School, UTHealth Houston, Texas; Associate Director, Stroke Transitions Education and Prevention (STEP) Program; Memorial Hermann Health System	Stroke survivorship, post-stroke trauma and PTSD, caregiver burden, health equity, telehealth and care transitions, and multidisciplinary stroke rehabilitation and outcomes research	Contributed to team working on literature review and associated chapter summary for Brain Health and dietary patterns
Jamie Olson	MGPS	Vice President of Policy and Advocacy, Feeding Texas	Tracking food insecurity, coalition building and leading around nutrition, nutrition policy	Contributed content on food insecurity and the success of public nutrition programs in contributing to healthy eating
Kevin Peng	MD	Internal medicine resident at UT Southwestern Medical Center	Background in medicine, culinary medicine, research, and business	Informed education strategies for graduate medical education

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Sydney Pryor	PhD, MPH	Research Scientist and Adjunct Professor, Department of Exercise and Nutrition Sciences at GW Global Food Institute and George Washington University Milken Institute School of Public Health, Washington, DC	Public health researcher, has expertise in food systems science and policy for health promotion, international nutritional health	Contributed content on food systems and sustainable diets
Ronna Robbins	PhD, RD, LD	Professor at TWU	Dietitian researcher, expertise in older adults	Data extraction
Madalyn Rosenthal	PhD	New PhD grad, research program coordinator at UT Austin in Nutrition	PhD in Nutrition from UT Austin (new grad); has expertise in UPF research and passionate about med-ed, physician-dietitian collab.	Co-lead for literature review for metabolic health and dietary pattern and associated chapter; expert input on educational strategies in medical education and primary care
Lona Sandon	PhD, Med, RDN, LD, FAND	Associate Professor, UT Southwestern Medical Center	Nutrition and Dietetics, Education Technology, Health Studies Education; Health Promotion/Disease Prevention, Sports Nutrition, Nutrition Media Communication	Guideline and graphic feedback

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Emma Saving	MPH	Culinary Medicine Program Coordinator at UTSW	MPH in Health Services Organization from UTHealth Houston, BA in Biology from Rice University, research experience in health promotion, implementation science, physical activity, Food as Medicine, culinary medicine; nutrition interventions for chronic disease and food security	Contributed to background section on current state of nutrition, dietary patterns, and chronic disease in Texas and the related need for further nutrition education; organized SME information
Janet Scott-Carrier	MEDL, BS Kinesiology	Aldine ISD teacher	Professional public-school educator; has years of experience teaching PE for middle schoolers and high schoolers, has coached many sports for similar-aged children and youth, and teaches kids to track and prioritize physical activity; school health education	Contributed content for primary school nutrition education section
Becca Smith	MS, RD, LD, SNS	Director of Community Health and Nutrition Education, San Antonio Food Bank	Dietitian, has done research, public health lens, CHEF program culinary education for families at SAFB, nutrition security health equity	School and community nutrition implementation strategies

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Jocelyn Srigley	MD, MSc, FRCPC	Clinical Assistant Professor, Pathology and Laboratory Medicine, UBC; BCCH/BCCHRIBC Women's Research Institute, University of British Columbia; visiting assistant professor at UT Southwestern	MD, studies microbiome and lifestyle medicine/culinary medicine, Infectious Diseases and Immunology Microbiology; international dietary guidelines	Contributed review and summary of international dietary guidelines focused on Brazil, Chile, and Canada and impact of UPF regulation
Solenn Thircuir	PhD	Medical sociologist and researcher at UC Santa Cruz	Medical sociologist and researcher at the University of California, Santa Cruz; previous PI at UC Berkeley SPH on implementation of nutrition in medical education in France and the United States; work centers on healthcare systems, innovation adoption, and clinical practice; international dietary guidelines	Contributed review and summary of international dietary guidelines review focused on France, UK, and Italy and impact of scoring systems
Vanessa Thyne	MS	PhD student at TWU	PCOS	Data extraction
Cynthia Warren	PhD, RD, LD	Professor at TWU	Food and Nutrition Scientist, nutrition education, UPF	Guideline and graphic feedback

Name	Credentials	Title/ Affiliation	Training/Area of Expertise	TNAC Contribution
Willis Wong	MD, MBA, MS	Internal Medicine resident at UT Southwestern Medical Center	Cardiology fellow (soon to be) with preventive cardiology and culinary medicine research background. Duke med school and masters' programs, culinary medicine research experience, and business school training	Contributed content for AHA/ACC dietary guidelines review and potential economic implications of dietary improvements in Texas

Appendix C. Texas Dietary Guidelines Framework Case Examples and Strategies

Case Examples of Texan Diets through Real Life Framework (How Texans Can Cook Healthy Foods in Real Life)

Busy Family of Four

Limited time, moderate cooking skills, reasonable access to food

Lunch or Dinner: Sheet Pan Meals

One pan, one oven, and minimal cleanup. Arrange protein and vegetables on a sheet pan, roast at 400–425°F for 20–30 minutes while helping with homework.

Easy combinations to rotate: (Mix and match proteins and vegetables per your likes and needs)

- Chicken pieces + broccoli florets + sweet potato cubes + olive oil
- Salmon fillets + asparagus + cherry tomatoes+ slice of avocado
- Steaks + bell peppers + zucchini + onion + slivered almonds
- May pair with a simple whole grain: Brown rice, quinoa, millet, or barley

Time savers: Wash and chop vegetables early in the week or on weekends and store in daily/meal portions so weeknight sheet pans come together in under 10 minutes of hands-on time. Can batch cook grains early in the week to round out the plate without adding active cooking time.

Key message: Healthy eating doesn't require complicated recipes or lots of time. A sheet pan, whole food ingredients, and basic seasoning (olive oil, salt, garlic powder) can produce a nourishing, satisfying dinner that a family of four can repeat week after week. Convenience and quality can live together.

Breakfast: Sheet pan eggs — crack a dozen eggs into a sheet pan (grease with olive or avocado oil first) with diced vegetables (optional: add sprinkled cheese); bake at 375°F for 15 minutes, slice into squares and refrigerate

- Overnight oats, buckwheat or chia pudding in mason jars with milk or yogurt of choice (dairy, soy, almond, coconut, pea), nuts and berries (assemble Sunday night, grab all week)
- Hard boiled eggs (cooked in bulk) + fresh fruit + left over sheet pan vegetables

Key message: Breakfast for a family doesn't have to happen in real time every morning. One session can stock the refrigerator with ready-to-grab whole food options that make mornings simpler

College Student in Dorm

Limited time, lack of a full kitchen with limited cookware, strict budget

Lunch and Dinner: Microwave "baked" potato or sweet potato topped with jar or can of beans, cheese, meat or seeds, salsa, avocado, and a side of shelf-stable fruit (apples, tangerines, bananas).

Key Message: Healthy eating does not require extensive cooking skills, equipment, or ingredients. Small improvements and simple meals can support health during busy life stages. If cooking or reheating in a microwave, remove from plastic packaging and place food in glass before heating.

Single Adult

Limited transportation, tight budget, limited cooking skills due to experience or mobility issues

Lunch and Dinner: One-Pan Stovetop Meals

Easy combinations to rotate:

- Canned or jarred black beans (rinsed and drained) + frozen corn + salsa + eggs
- Frozen stir-fry vegetables + chicken + soy sauce over instant brown rice
- Lentil soup from dried lentils (low-cost, no soaking required, 25 minutes) + diced carrots and onions
- Pantry anchors: Canned or jarred beans, dried lentils, frozen vegetables, eggs, olive oil, garlic. These are affordable, nutrient-dense, and shelf-stable

Batch prep idea: Cook a large pot of lentils or beans on Sunday. Use throughout the week for different meals.

Key message: Eating well on a budget is possible with a short list of whole food staples. Canned and frozen options have similar nutrients to fresh and reduce cost and prep time.

Breakfast: Simple Whole Food Anchors

- Oatmeal, chia pudding, rice, quinoa, or buckwheat, topped with peanut butter and banana. Stir in yogurt or milk to increase protein intake
- Eggs scrambled with whatever vegetables are on hand (even the wilting ones) + fruit or whole grain or corn tortillas
- Protein smoothie – one to two cups dairy or plant-based milk, one to two scoops dried milk or protein powder, one cup blueberries, 1-½ banana
- Greek yogurt + frozen fruit (thawed overnight) + low sugar granola
- Nut or seed butter + sliced apple or other fruit or vegetable

Batch prep idea: A large container of overnight oats lasts four to five days in the refrigerator. Total cost per serving: under $1.

Key message: Breakfast doesn't require a recipe. A few reliable combinations built from affordable whole food staples are enough to fuel a full morning of class, work, or chores.

Couple with Food Insecurity

Limited money for food, special healthcare needs such as diabetes

Lunch and Dinner: Flavorful bean soup starting with dry beans or lentils and prepared with onion, carrot, and celery for a slow simmered, bulk-cook meal that could be eaten alone or with a whole grain bread or corn tortilla.

Optional: side of frozen vegetables, steamed or roasted.

Key message: Shelf-stable foods can be part of a healthy dietary pattern, and community food resource programs might be a great way to increase access. Eating seasonal produce and keeping foods that last a long time or can be frozen until ready to eat can reduce costs and minimize waste.

Older Adults or Adults with Disabilities

Moderate time; good cooking skills but with lower energy levels or mobility problems; transportation limits; lower budget; smaller appetite

Lunch and Dinner: Small-Batch Sheet Pan + Simple Soups

Cooking for one doesn't mean sacrificing nutrition.

Easy combinations to rotate:

- One chicken breast or thigh + green beans + baby potatoes on a sheet pan
- Salmon fillet + asparagus + lemon on a sheet pan
- Simple vegetable soup with canned or jarred tomatoes, beans, diced greens (like spinach, collards, or chard), and broth
- Egg-based meals (frittata, soft scramble) with whatever vegetables are on hand

Batch prep idea: Make a small pot of soup and portion into two or three meals. Freeze one portion in glass container to avoid food waste and build an inventory of homemade personal frozen meals.

Key message: Nutritional needs remain high even as appetite and cooking energy decrease. Smaller portions of nutrient-dense whole foods support health without generating waste or overwhelm.

Breakfast: Simple Whole Food Anchors

- Soft scrambled eggs with spinach and whole grain toast
- Warm oatmeal, chia or quinoa with walnuts, cinnamon, and sliced banana
- Yogurt parfait (dairy, almond, soy, coconut, cashew) with berries and a small handful of nuts
- Apple or celery with nut butter
- Batch prep idea: Mini egg muffins baked in a muffin tin (eggs + vegetables + Optional- cheese) store in the refrigerator for four to five days and require no morning effort

Key message: Protein and fiber at breakfast matter, especially as we age. They support muscle maintenance, blood sugar stability, and sustained energy. Nutrient dense meals are key when appetite is less.

Rural Ranching Family

Long distance to grocery store; seasonal work demands limit time; hunting, ranching, family traditions

Lunch and Dinner: Venison chili made with beans and tomatoes, salad or seasonal vegetables, and fruit.

Key Message: Traditional Texas foodways, including hunting, ranching, gardening, and preserving foods, can support healthy eating patterns when balanced with vegetables, legumes, whole grains, and appropriate portions.

Rural Texan with Limited Grocery Access

Long distance to grocery store; moderate time; moderate to high cooking skills

Lunch and Dinner: Pantry-Forward Meals with Strategic Fresh Purchases

Shop once or twice a month. Build meals around shelf-stable and freezer staples with strategic use of fresh items that last.

- Easy combinations to rotate:
- Dried pinto beans or frozen black-eyed peas + jarred or canned tomatoes + onion + homemade cornbread
- Frozen lean roast + potatoes + vegetables (fresh or frozen)
- Slow cooker chicken (frozen) + salsa + black beans + squash over rice

Produce that travels and lasts: Cabbage, carrots, sweet potatoes, onions, garlic, and apples hold up for weeks and are often available at local stores or farm stands.

Batch prep idea: Slow cookers and Instant pots are especially practical for rural kitchens. Cook a large batch and portion across the week or freeze.

Key message: Food access barriers require a different toolkit, not lower standards. Shelf-stable and frozen whole foods, long-lasting produce, and batch cooking can support excellent nutrition even when grocery trips are infrequent.

Breakfast Outputs: Pantry and Freezer-Forward Anchors

- Oatmeal, chia, quinoa, or buckwheat with nut butter or nuts and frozen fruit
- Eggs with salsa and corn tortillas + fruit
- Nut butter on homemade, whole grain bread with a banana or apple
- Grits with eggs and hot sauce + fruit

Batch prep idea: A large batch of oatmeal or other whole grain can be portioned and refrigerated for the week. Add variety with different toppings rather than different recipes.

Key message: A short list of shelf-stable, long-lasting whole foods can anchor a nutritious breakfast every day and help space out grocery runs.

Household Managing Chronic Disease

Reduced energy or transportation for grocery shopping; special healthcare needs

Dinner: Simple, one-pot meal (such as a stew or soup) with beans or meat and vegetables using low sodium broth and introducing spices and vinegar or lemon to brighten flavor before adding salt. Can be stored in fridge or freezer for leftovers and easy reheating on days when feeling unwell.

Key messages: Nutrition can be tailored to support health conditions (such as salt reduction) while remaining flavorful. Grocery pick-up or delivery services can be a free or low-cost way to lower shopping effort. Simple meals with leftovers can reduce cooking burden.

Person with T2DM Managing Blood Sugar

Moderate time; moderate cooking skills; good access to food; need blood sugar management.

Lunch and Dinner: Balanced Plate Sheet Pan

Eating healthy protein and fats together with high-fiber, healthy carbohydrates spread throughout the day are important to control blood sugar.

Easy combinations to rotate:

- Salmon + broccoli sheet pan + quinoa or brown rice on stove (can bulk cook)
- Diced tofu + cauliflower + red bell pepper in light curry on stove
- Lean pork roast + roasted Brussels sprouts + sweet potatoes
- Sheet pan shrimp fajitas with bell peppers and onion, served with small whole wheat or corn tortilla or beans
- Lean ground turkey or beef + zucchini + diced tomatoes and green chilis in a skillet (or sub black beans for turkey to make vegetarian)
- Cauliflower rice with protein and vegetable stir-fry

Batch prep idea: Pre-portion carbohydrate sides (quinoa, skin on sweet potato, beans) in consistent amounts to make plate-building automatic and reduce guesswork at mealtime.

Key message: Managing blood sugar does not require special foods or restrictions. Consistent meal timing, adequate fiber, minimally processed protein, and high fiber carbohydrate foods from whole foods are the foundation. Flavor and satisfaction remain.

Breakfast Anchors: Balanced Anchors

- "Scrambled" tofu + sautéed spinach + one slice whole grain toast
- Plain, high protein yogurt (dairy, soy, pea protein) + berries + chia seeds + small handful of nuts (optional to add protein powder)
- Vegetable egg "muffins" with beans + small piece of whole fruit

Batch prep idea: Pre-portion yogurt servings with toppings already measured. Removes decision-making at the most rushed time of day and supports consistent carbohydrate intake.

Key message: Breakfast sets the blood sugar tone for the entire day. A protein and fiber-forward first meal supports more stable blood sugars and energy through the afternoon.

Multicultural Household

Limited time; blending food traditions from more than one culture

Dinner: Grilled salmon with Mexican-style black beans, roasted vegetables, brown rice, mango salsa, and a side salad.

Key Message: Healthy eating can incorporate foods and traditions from multiple cultures. Families can combine favorite foods and flavors while following the same foundational principles of balance, variety, and nutrient density.

Breakfast:

- Eggs prepared in culturally familiar ways (fried, spiced, with herbs) served with corn tortillas or rice
- Warm, spiced oatmeal, quinoa, buckwheat or chia with cardamom, cinnamon, and nuts bridge across many food traditions
- Bean-based breakfast dishes (black beans or pinto beans with eggs) are familiar in many Latin American, Middle Eastern, and African food traditions
- Fresh fruit with high protein yogurt (dairy, soy, pea protein) are universally familiar, locally available

Batch prep idea: A batch of seasoned beans works equally well as a breakfast side, lunch addition, or dinner base and maximizes one cooking session across multiple meals and cultural contexts.

Key message: Breakfast traditions vary enormously across cultures, and many are already nutritionally excellent. The goal is not to adopt American breakfast norms but to find local ingredients that support the nourishing patterns already preferred by household members.

Multigenerational Household

Multigenerational South Asian household with strong food identity and family traditions for cultural foods; family member with metabolic associated fatty liver disease [MASLD]

Lunch and Dinner: Whole wheat roti or rice served with dal (lentils), grilled or baked tandoori-style chicken, sauteed okra, and fresh fruit for dessert.

Key message: Traditional South Asian dietary patterns can align closely with healthy eating principles. Emphasizing legumes, vegetables, whole grains, and balanced portions while limiting UPF and sources of added sugars can support health without abandoning cultural identity or foods enjoyed by the whole family.

Breakfast

- Vegetable upma (semolina with mustard seeds, curry leaves, onion, peas, and carrots)
- Moong dal chilla (savory lentil crepes) topped with fresh herbs and plain high protein yogurt (dairy, soy, pea protein)
- Poha (flattened rice) with turmeric, mustard seeds, peas, and a squeeze of lime
- Whole wheat roti with a small amount of nut butter or egg bhurji (spiced scrambled eggs with onion, tomato, and green chili)

Batch prep idea: Moong dal batter can be made ahead and stored in the refrigerator for 3–4 days, making chilla a quick weekday option. A large batch of poha takes under 15 minutes and serves the whole household.

Key message: Traditional South Asian breakfasts are often already aligned with MASLD nutritional priorities as they are legume-based, vegetable-forward, and moderately portioned. Small adjustments in preparation method and reducing added

fats preserve cultural identity while actively supporting liver health for the whole family.

Food Allergy Household with Picky Eaters

Medical needs (nut and dairy allergy; gluten intolerance or Celiac disease), meaning (different preferences across family members – one vegetarian, others not)

Dinner: Single ingredient, allergen-free foods to minimize UPFs and provide customization, such as "build your own" burrito bowls with black beans, whole grain rice, and lean, ground taco meat on corn tortillas or lettuce wrap with optional toppings of avocado, tomato, purple cabbage, and salsa

Key message: Variety and options within a meal can support a healthy diet

Allergen-Free Whole Food Breakfast Anchors:

- Scrambled eggs with beans or a veggie egg scramble (dairy-free can avoid cheese and milk, consider nutritional yeast for flavor) with corn tortillas and salsa. These are naturally nut-free, dairy-free, and customizable
- Oatmeal or chia pudding made with soymilk or coconut milk, topped with seeds (sunflower or pumpkin that are nut-free) and fresh or frozen fruit
- Avocado toast on Buckwheat whole grain bread with a fried egg or sliced tomato for the vegetarian
- Smoothies made with non-dairy milk base, frozen fruit, dark leafy greens, and seeds can be easy to customize
- "Build your own" yogurt parfait using dairy-free, unsweetened yogurt with granola (verify nut-free label) and fresh fruit

Customization nudge: Set up a simple breakfast bar with base items (oatmeal, eggs, toast) and toppings in small bowls, such as seeds, fruit, salsa, avocado. Picky eaters feel control and allergen management stays simple because toppings are separated and labeled.

Batch prep idea: A large batch of egg muffins made without dairy or nuts can be stored for the week. Use silicone muffin liners to avoid any cross-contact concerns and customize fillings by preference.

Key message: Managing food allergies alongside picky eating is less about finding the perfect recipe and more about building a reliable system. Single-ingredient whole foods

with customizable assembly reduce allergen risk, minimize conflict at the table, and keep nutrition on track across different preferences.

Appendix D. Evidence-Based School Resources and Examples

School resource examples are available on the TNAC webpage: https://www.dshs.texas.gov/texas-nutrition-advisory-committee.

Appendix E. Medical Student Perspectives

Student Perspectives on Nutrition Education Across Texas Medical Schools: Qualitative Findings and Recommendations for Statewide Curriculum Medical Implementation

Author List:

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Executive Summary

Nutrition is central to the prevention and management of many chronic diseases, yet medical students across Texas described a persistent gap between the recognized importance of nutrition in patient care and the training they currently receive to address it in practice. This qualitative analysis drew on interviews with 18 unique medical student participants across all 14 Texas medical schools receiving state funding to better understand how students perceive the current status of nutrition education, how prepared they feel to counsel patients, what nutrition-related responsibilities they believe physicians should hold, and what educational approaches are most likely to be effective and feasible.

Students consistently described nutrition as important but inconsistently prioritized within medical training. Most participants did not say nutrition was entirely absent; rather, they described it as fragmented, variably emphasized, hidden within other content, and frequently focused on board-style factual knowledge rather than practical counseling. Some students described more structured nutrition exposure through integrated blocks, lifestyle medicine pathways, or rural/community-based clinical experiences, but even these students emphasized that the most valuable learning occurred when nutrition science was translated into practical, patient-facing counseling. Students commonly reported feeling comfortable discussing the general importance of diet, but less prepared to provide specific, individualized, culturally responsive, and feasible nutrition guidance to patients.

Participants also emphasized that meaningful nutrition counseling cannot be separated from the realities of food insecurity, cost, time, access, transportation, and culture. Many students believed physicians should be able to perform basic nutrition screening and counseling, recognize common diet-related issues, and connect patients with appropriate team members and resources; however, they did not believe physicians could replace dietitians or other nutrition professionals, as they occupy distinct, vital niches within the healthcare landscape.

Students strongly preferred integrated, applied, and interactive learning approaches over more passive, add-on modules. Recommended modalities included case-based teaching, culinary medicine opportunities, Objective Structured Clinical Examinations (OSCEs), direct patient encounters, community resource navigation through interprofessional education sessions, and the incorporation of nutrition into existing organ-system and clinical-skills curricula.

These findings are highly relevant to the current state and federal policy environment. The TNAC, established in 2025, is charged with examining the impact of nutrition on

health, reviewing evidence related to diet and UPF, providing education on health effects of UPF, and developing and maintaining dietary and nutritional guidelines. At the federal level, the U.S. Department of Health and Human Services (HHS) and the Department of Education announced that 53 medical schools across 31 states committed to requiring at least 40 hours of nutrition education, or a 40-hour competency equivalent, for students beginning in fall 2026; HHS also developed 71 core nutrition competencies as a flexible guidance framework informed as per a 2024 JAMA consensus statement.

In summary, the findings of this report suggest that Texas medical schools should avoid approaching medical nutrition education as a matter of adding hours. Alternatively, a statewide response should focus on longitudinal, competency-based, clinically grounded, and context-dependent implementation that equips future physicians with foundational nutrition knowledge, communication skills, resource-navigation ability, and collaborative referral practices to best serve patient needs.

Background and Policy Context

Diet-related disease remains one of the major drivers of morbidity, mortality, and health care expenditure in the United States. Diet-related cardiometabolic disease carries an estimated annual health care cost burden of approximately $50 billion, while medical students and physician trainees have historically lacked nationally required nutrition competencies.[1] In 2024, a 37-member expert panel used a modified Delphi process and reached greater than 70% consensus on 36 recommended nutrition competencies for medical education.[2]

This national momentum is now directly relevant to medical education in Texas. The Texas Legislature established the TNAC in 2025 and charged it with examining the relationship between nutrition and health, reviewing evidence related to UPF and health, providing education on UPF impact on health, and developing and maintaining dietary and nutritional guidelines.[3]

In parallel, HHS announced in 2026 that 53 U.S. medical schools voluntarily committed to integrating at least 40 hours of nutrition education or an equivalent competency-based approach, and that HHS created a 71-competency framework to support schools that prefer competency-based implementation rather than strict hourly requirements.[4]

Prior medical education literature has demonstrated the importance of student-driven feedback and the beneficial implementation of curricular changes when student recommendations are solicited.[5] Therefore, this project seeks to inform how nutrition

policy directives might be best implemented in Texas medical education from the perspective of learners themselves.

Objectives

This report addresses four primary research questions:

1. What are current student perspectives on the status of nutrition education in medical school?
2. How confident do medical students feel in their abilities to address patient nutritional and lifestyle concerns?
3. What nutrition-related tasks do medical students think physicians should have the ability to counsel patients on?
4. What interventions or learning modalities are ideal to promote student engagement and meaningful integration of nutrition and lifestyle topics into medical training?

Methods

This report is based on a qualitative thematic analysis of interview transcripts from 18 unique medical student participants representing all 14 Texas medical schools receiving state funding. To minimize the risk of participant identification, quotations are labeled only by participant number (P1-18), and institutional affiliations and identifiable details were removed from analytic reporting.

Interviews explored experiences with nutrition education in medical school, confidence in addressing patient nutrition concerns, perceptions of physician scope of practice, exposure to dietitians and other health professionals through interprofessional education learning opportunities, personal reflections on nutrition and wellness, and recommendations for curricular changes.

Interviews were qualitatively coded using an initial/open coding process, then grouped into descriptive/topic-based categories, and finally synthesized into major themes and subthemes. Thematic analysis was performed iteratively across all transcripts. The final thematic framework reflects recurring patterns across the full interview set, including variation in curricular structure, assessment incentives, patient-facing counseling preparation, rural/community health exposure, and student recommendations for applied learning.

Findings

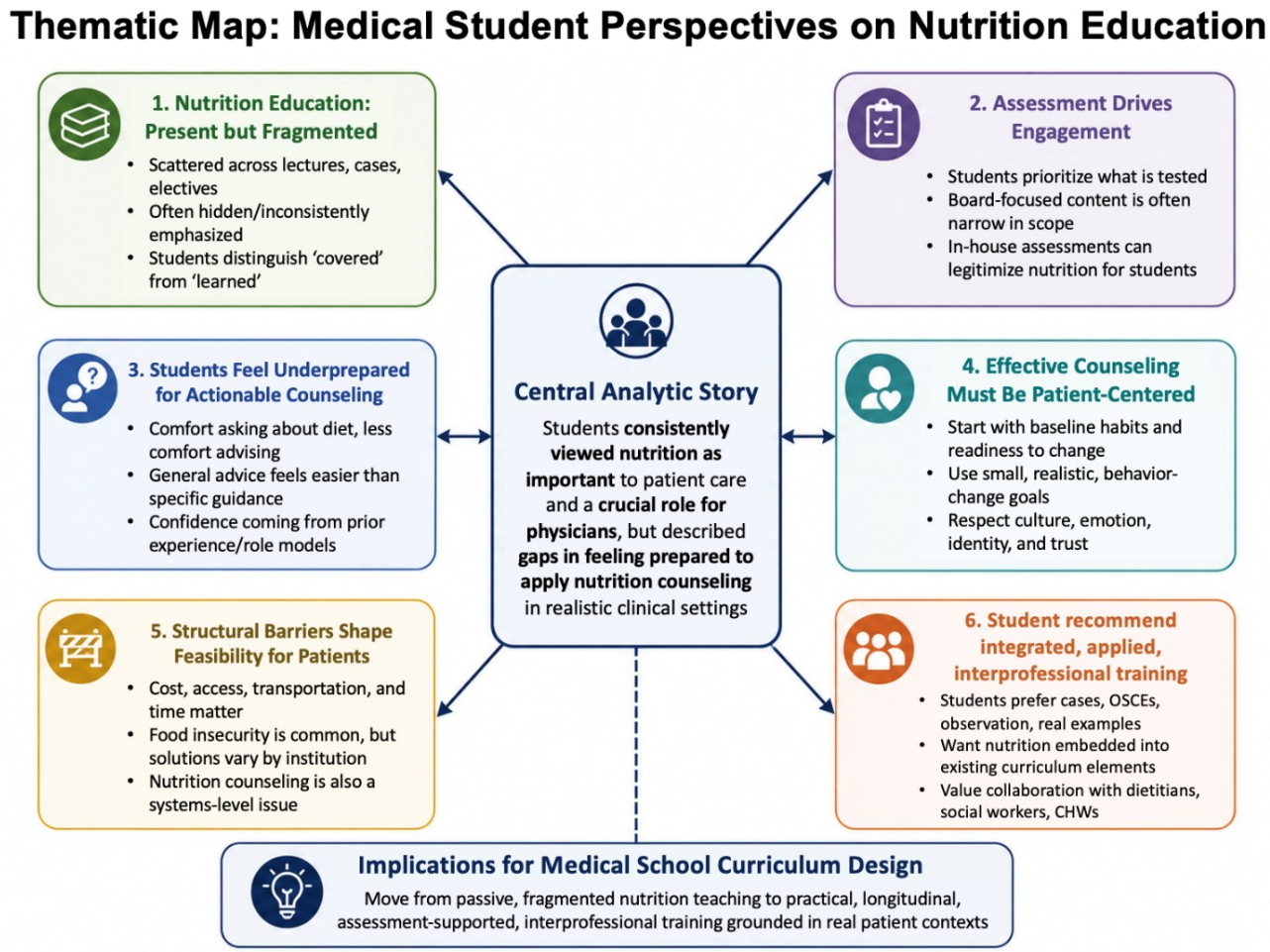

Figure 1. Thematic map representing major themes surrounding student perspectives on nutrition education. This map illustrates how student perspectives clustered around seven major themes: (1) nutrition is present but fragmented; (2) assessment drives engagement; (3) students value nutrition but feel underprepared for individualized counseling; (4) meaningful counseling must be patient-centered, culturally responsive, and feasible; (5) structural barriers shape what is realistic for patients; (6) physicians have a foundational but not exclusive role in nutrition care; and (7) centrally, students prefer applied, integrated, interprofessional learning formats.

Theme One. Nutrition education is present, but fragmented, inconsistently prioritized, and often not experienced as clinically usable

Across the dataset, students frequently described that nutrition education was dispersed in small bits and pieces across the curriculum: biochemistry, organ blocks, doctoring courses, social determinants sessions, lifestyle medicine content, miscellaneous extra lectures, electives, or extracurricular experiences all included components of nutrition. However, students repeatedly distinguished between nutrition being technically 'included' and nutrition being meaningfully implemented in a clinically transferable fashion:

"I don't want to say nutrition wasn't included...it was there. But it was kind of an aside, and not something that felt emphasized enough to actually prepare me to use it clinically" (P14).

Many participants described nutrition content as fragmented, peripheral, or easy to overlook. Some recalled learning about vitamins, deficiencies, metabolic disorders, or disease associations, but felt this did not translate into practical counseling for common conditions such as diabetes, cardiovascular disease, obesity, gastrointestinal disorders, or renal disease. Several students reported that some of the most memorable and practically useful nutrition learning came from experiences outside the formal curriculum, such as culinary medicine sessions, elective courses, interest groups, personal background, or extracurricular service experiences.

At the same time, a minority of students described more intentional nutrition exposure through integrated nutrition blocks, lifestyle medicine pathways, or rural/community-based clinical experiences. These examples suggest that nutrition education can feel more meaningful when it is connected to relevant courses and patient-facing counseling. However, even in more structured settings, students emphasized that high-level nutrition science must be translated into language and tools that patients can understand and use:

"[Patients] are intelligent. They are able to understand things. They just have to be taught, and no one has taught them yet" (P17).

Overall, students did not primarily describe a total lack of exposure to nutrition education. Rather, they described a lack of rationality, longitudinal repetition, and clinical integration with the existing course material they were engaging with.

Theme Two. Assessment drives engagement, but tested nutrition does not always match patient-care needs

A consistent finding across transcripts was that students learn what is treated as important in the curriculum, and assessment is a major signal of importance. Participants frequently noted that if nutrition is not tested, graded, or incorporated into required learning activities, it is likely to be deprioritized amid the volume of other medical school content:

"You kind of learn very quickly in medical school what matters based on what's tested" (P1).

"If it's not something that's going to show up on an exam, it's hard for students to spend a ton of time on it when everything already feels overwhelming" (P3).

At the same time, students also observed that nutrition content that appears in exams may not be the same nutrition content they need in clinical care. Board-style nutrition was often described as focused on deficiencies, associations, or fact-based recall rather than counseling. Several students described being able to recognize terms or disease-diet pairings without feeling equipped to answer common patient questions such as: What should I eat? What can I afford? What substitutions can I make within my culture or household routine? How do I realistically make this change?

Importantly, some students also emphasized that hands-on or simulation-based learning may remain memorable even when not heavily tested, suggesting that assessment is a critical but not exclusive driver of meaningful learning. This observation aligns with broader national discussion. Prior literature has emphasized that implementation challenges include crowded curricula and the need for practical integration, and it specifically highlights evidence-based guidance, food insecurity screening, collaborative nutrition care, and public health nutrition as core competency areas.

Resolving these reported challenges in nutritional assessment should be concentrated on prioritizing practical, clinical-vignette-based nutrition assessment strategies on examinations and incorporating interactive learning opportunities that focus on student engagement and active participation, even when formal assessment may not follow.

Theme Three. Students value nutrition, but many feel underprepared to move from general advice to individualized counseling

Students across interviews generally believed nutrition counseling is important and that physicians should be able to discuss it. However, many did not feel adequately prepared to do so in a concrete, patient-centered way.

A common pattern emerged: students felt able to provide broad dietary advice. For example, students consistently reported confidence in advising patients to reduce salt, lower sugar intake, eat more vegetables, or follow a 'healthier' diet. However, they felt less confident translating this into detailed, actionable, and individualized counseling strategies:

"I can tell a patient they should eat healthier or lower their carbs…but if they ask me what that actually looks like for them, I don't really feel prepared to answer that" (P14).

"I feel comfortable saying nutrition matters. I don't always feel comfortable turning that into an actual plan for a patient" (P7).

Students often described uncertainty around specific meal recommendations, diagnosis-specific guidance, realistic dietary substitutions, culturally relevant counseling, and behavior change strategies that would not overwhelm patients. Additionally, students also emphasized that clinician counseling should not require patients to give up all foods they enjoy or completely overhaul their diet. Across interviews, participants described the need for small changes, moderation, familiar substitutions, and explanations that acknowledge patients' cultural and family food practices. Thus, many students understood the importance of nutrition conceptually but felt they lacked the practical skills to move from conceptual importance to real-world implementation in clinical settings.

Notably, confidence was often higher among students who had prior exposure to nutrition through undergraduate work, extracurricular involvement, personal interests, or strong clinical role models. This suggests that current nutrition preparedness may depend heavily on pre-existing interest or informal opportunities rather than consistent curricular training in medical school itself.

Theme Four. Meaningful nutrition counseling must be patient-centered, culturally responsive, and feasible

Students repeatedly emphasized that effective nutrition counseling cannot consist of generic instructions separate from patients' lived realities. Participants described food as tied not only to health, but also to culture, tradition, family life, identity, cost, routine, and stress:

"You can't just tell someone to completely stop eating the foods they grew up with. It has to work within their culture and what's realistic for them" (P4).

Students requested nutrition education that would help them counsel patients in ways that are realistic and respectful. This included understanding how to:

- Start from a patient's current diet and habits.
- Recognize readiness to change.
- Make incremental recommendations and participate in cooperative goal setting.
- Adapt recommendations to cultural food patterns.
- Avoid judgment or unrealistic expectations.

Several students emphasized that culturally responsive counseling should not mean simply telling patients to abandon familiar foods in favor of standardized diets. Instead, students wanted tools to help patients make healthier changes within their existing food traditions. Interviewees also demonstrated a strong awareness that behavior change requires empathy. Some explicitly connected their own difficulty maintaining healthy habits during demanding training to a greater appreciation for how hard lifestyle change may be for patients facing work demands, caregiving, limited resources, or chronic stress.

Thus, the push for increased education in cultural competency and feasibility should be integrated with training in motivational interviewing and goal setting. Prior literature has highlighted beneficial outcomes from structured motivational interviewing training in nutrition-focused contexts; this style of learning would provide a highly engaging, interprofessional style of instruction that certain students reflected positively upon when implemented in their respective curricula.[6]

Theme Five. Food insecurity and structural barriers shape what is realistic for patients, making nutrition counseling a systems-level and team-based issue

Another major theme that emerged was that nutrition counseling cannot be separated from structural barriers for patients. Students frequently discussed the challenge of food insecurity, food deserts, transportation barriers, cost, lack of time, limited grocery access, insurance barriers, and the unique challenges faced by patients in underserved communities:

"A patient can know exactly what they should eat and still not realistically be able to do it" (P3).

"We talk a lot about food deserts and disparities, but not always what to do when a patient actually can't afford the recommendations" (P12).

Many students felt they had gained some awareness of these barriers during training but felt less prepared to respond to them in practical ways. They wanted more training not only on recognizing food insecurity, but also on navigating community and governmental resources, including food pantries, produce programs, Supplemental Nutrition Assistance Program (SNAP), and other supports. Students often saw this as an especially important area because it could help make nutrition counseling more actionable for patients.

This theme closely mirrors national competency directions. The JAMA commentary previously described states that proposed competency areas include screening for food insecurity, referring patients to appropriate resources, recognizing socioeconomic factors associated with nutrition and health, and working collaboratively with registered dietitian nutritionists and other health practitioners.[2,6] It also aligns with the HHS competency framework, which notes that schools may engage nutrition professionals and other experts as part of a broader competency-based strategy.[4]

Students' reflections suggest that a high-quality nutrition curriculum should treat food insecurity and access as core clinical realities, with applicable solutions and community resources integrated within these discussions of patient inequities. One particularly topical recommendation to address these points was a "cheat-sheet" regarding county- and city-level nutritional resources for medical trainees and providers to reference when seeing patients:

"I don't feel equipped [right now], but I'm sure if someone gave me a resource, I would be comfortable giving it to people" (P16).

Certain institutions already have such resources, but all Texas medical schools could consider coordination to make locally relevant resources available for all students to support provision of accurate, updated recommendations to patients facing structural barriers to accessing high-quality nutrition.

Theme Six. Students see physicians as foundational screeners, counselors, and coordinators, not substitutes for dietitians

Students generally did not advocate that physicians should become nutrition specialists or fulfill roles like that of dietitians. Instead, they described wanting a layered, team-based model of responsibility. Participants largely believed physicians should be able to:

- Ask general questions about diet and lifestyle.
- Recognize diet-related contributors to disease.
- Provide foundational, evidence-based guidance for treating common conditions with lifestyle strategies, including dietary change.
- Identify food insecurity and other barriers.
- Encourage realistic behavior change.
- Know when to refer for additional support based on specific patient context.

Simultaneously, students consistently viewed dietitians and nutrition professionals as essential for more detailed diet counseling, meal planning, complex disease-specific dietary management, and intensive behavioral support. Social workers, community health workers, and other resource navigators were also viewed as crucial where the main problem involves access, insurance, transportation, SNAP enrollment, or community support:

"I don't think doctors need to become dietitians, but we should know enough to start the conversation and recognize when someone needs more support"*(P5).*

"Part of our role is helping connect patients to the right people and resources" (P2).

Students from rural and primary-care-focused medical schools observed that physicians and medical students may require more capacity to discuss nutrition directly with patients. In hospital settings, nutrition counseling may be more likely to be

delegated to dietitians or other team members, while individuals in rural/primary care settings might not have access to these interdisciplinary resources or may encounter uninsured/underinsured patients who are less capable of accessing these other health professionals. This reinforces the need for physicians to have baseline counseling skills while also understanding how to collaborate with nutrition professionals and resource teams when they are available.

A particularly useful nuance was that undergraduate medical education and graduate medical education may play uniquely different roles. Some students felt that all medical students should receive generalized baseline nutrition competence, especially for conditions commonly encountered in general medicine, while more robust specialty-specific training may be more appropriate during residency and fellowship. This perspective is also consistent with the broader national conversation. JAMA's commentary on the competencies emphasized interdisciplinary collaboration with registered dietitian nutritionists and other health practitioners, while also noting that implementation requires thoughtful integration into already crowded curricula.[2]

Theme Seven. Students prefer integrated, applied, interprofessional nutrition education embedded into existing curricula rather than passive add-ons

If there was one especially strong implementation message across the interviews, it was this: students do not simply want "more lectures" or "more modules." Participants repeatedly favored learning formats that were, practical, clinically relevant, interactive, integrated into existing curricular structures, and connected to patient care.

"If nutrition is integrated into cases and clinical skills, students will take it more seriously than if it's just another optional module" (P14).

"The things that stick are the things where you actually have to use it with a patient" (P2).

The most commonly endorsed modalities included:

- Case-based learning
- Organ-block integration
- OSCEs and standardized patient encounters
- Clinical skills sessions
- Interprofessional teaching with dietitians or other professionals

- Culinary medicine experiences
- Resource navigation and food-access teaching from social workers or community navigators
- Examples and scripts for common patient questions
- Structured exposure to counseling for common chronic diseases

Students identified several concrete instructional approaches that may make nutrition education more clinically useful: case-based learning with interprofessional input, patient-facing handouts, brief counseling scripts, rural/community clinical exposure, applied lifestyle medicine assignments, and recurring wellness/lifestyle content that revisits nutrition alongside physical activity, sleep, and behavior change. These suggestions point toward a model that is both integrated and longitudinal, rather than a one-time nutrition lecture or passive module. In contrast, students often described passive modules, podcasts, or isolated add-on requirements as low engagement, especially when they were not well integrated or did not clearly connect to patient care.

These findings are highly consistent with the implementation challenges identified in national literature. Integrating nutrition into an already packed curriculum will require creative approaches and collaboration, rather than an extension of stand-alone content.[2]

Discussion

This qualitative analysis suggests that medical students in Texas view nutrition as both clinically important and educationally under-realized. The key issue is not necessarily a general absence of content but rather misalignment between how nutrition is currently taught and how students need to use it in practice.

Three broad conclusions emerge:

5. First, students are calling for a shift from disjointed exposure to nutrition knowledge to clinical usability. They specifically request training that prepares them not only to identify nutrition-related concepts, but to talk with patients about food in ways that are specific, feasible, culturally responsive, and sensitive to real-world barriers.
6. Second, students are calling for a shift from isolated content to integrated competencies. They do not see nutrition as something that should be siloed in a single course or in a set of add-on modules. In contrast, they see nutrition as

inherently connected to chronic disease care, prevention, communication, social determinants of health, and interprofessional collaboration.

7. Third, students are calling for a shift from individual counseling to systems-based practice. They recognize that nutrition care is constrained by food access, cost, transportation, insurance coverage, and community infrastructure. As a result, they want training in both counseling and resource navigation to serve all patients.

These conclusions fit closely with recent developments within the national policy landscape. HHS's 2026 announcement describes a move toward either 40 hours of nutrition education or a 40-hour competency equivalent, supported by a 71-competency framework informed by the JAMA consensus work.[2,4] These additional perspectives from Texas medical students should add additional urgency to bringing about effective changes, as the Committee has explicit legislative responsibilities related to education, evidence review, and dietary guidance for the state.

For Texas, the implications are clear: a successful statewide strategy should not flatly mandate hours for medical schools to implement. Changes should be focused on supporting and guiding medical schools toward foundational physician competencies**,** interprofessional partnerships, and implementation approaches that are realistic within medical curricula and locally adaptable.

Recommendations

1. Adopt a competency-based rather than hour-only approach

Texas medical schools should align with the spirit of current federal developments by focusing on what students should be able to do, not only on how many hours of nutrition content they receive. A competency-based approach would better support durable implementation across schools with different curricular structures.

2. Define foundational physician-level nutrition competencies for all students

All graduating medical students should be able to:

- Obtain a basic diet history.
- Identify common diet-related contributors to chronic disease.
- Provide foundational evidence-based counseling for common conditions.
- Screen for food insecurity.
- Discuss nutrition in culturally respectful ways.

- Recognize physician limits of expertise and refer appropriately.

3. Integrate nutrition into existing curricular structures

Rather than creating additional stand-alone modules, schools should embed nutrition into:

- Organ-system blocks
- Clinical skills/doctoring courses
- OSCEs and standardized patient cases
- Ambulatory and primary care rotations
- Social determinants of health activities
- Interprofessional education

4. Prioritize applied learning modalities

Students' feedback strongly supports case-based learning, counseling practice, culinary medicine, OSCEs, and other interactive approaches. These should be prioritized over passive or optional content, frequently delivered through online, asynchronous modules.

5. Treat food insecurity and resource navigation as a core curriculum

Students should learn to both identify barriers patients experience in accessing high-quality nutrition and connect patients with practical supports such as SNAP, food banks, produce programs, and local community resources.

6. Strengthen interprofessional learning

Dietitians, nutrition professionals, social workers, diabetes educators, and community health workers should be incorporated directly into medical training, both to model collaborative care and to clarify role boundaries.

7. Use assessment to legitimize nutrition education

Nutrition should appear in meaningful, formal assessments, including applied questions, OSCEs, and required clinical activities focusing on the currently available consensus on recommended core competencies.[2] Assessment should avoid pure factual recall and instead emphasize practical counseling points and common patient conditions/requests.

8. Develop shared statewide tools to reduce burden on schools

The TNAC could help support medical schools working to implement nutrition education by sharing available resources such as:

- Culturally tailored substitution guides
- Resource-navigation templates
- Standardized OSCE cases
- Faculty development materials
- Curricular mapping tools tied to competencies

9. Continue incorporating student voices into implementation strategies

Students are uniquely positioned to identify where curriculum elements feel meaningful. Ongoing student feedback should be built into statewide and institutional evaluation efforts to help optimize the iteration of new nutritional education elements.

Strengths and Limitations

A major strength of this project is that it captures student perspectives from across 14 Texas medical schools, offering a broad view of learner experiences in the state. The qualitative design also allowed students to describe not just whether nutrition education is present, but how it is experienced and where it breaks down in practice.

At the same time, this project reflects self-reported perceptions rather than direct curricular audits or observed competence. Participants may have had different personal interests in nutrition, and interview depth varied by participant. In addition, because anonymity was prioritized, findings are intentionally not linked to specific schools, which limits institution-level comparison but strengthens participant anonymity.

Conclusion

Texas medical students view nutrition as essential to patient care, but many do not yet feel adequately prepared to provide individualized, feasible, and culturally responsive nutrition counseling in clinical practice. Their reflections suggest that the central challenge is in ensuring that nutrition education is visible, clinically useful, interactive, integrated, and responsive to the realities patients face.

For the TNAC and other state stakeholders, this report offers a practical takeaway: effective implementation of nutrition education in medical schools should emphasize foundational competencies, team-based care, applied learning, and structural awareness in a way that each school can locally tailor to serve the needs of their patient populations. As Texas continues to develop dietary guidance and public

education efforts, medical education represents an important upstream investment opportunity. A thoughtful framework could help ensure that future physicians are better prepared not only to recognize the unique role of nutrition in health, but to additionally translate that knowledge into effective care that best serves their patients.

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Theme 1. Nutrition education is present but fragmented, inconsistently prioritized, and often not experienced as clinically usable

Sub-themes	Participant/transcript numbers where discussed
Nutrition is included in the curriculum, but often appears scattered across lectures, cases, electives, doctoring courses, or informal experiences rather than as a coherent longitudinal thread	P1, P2, P3, P4, P5, P7, P8, P9, P11, P12, P13, P14, P15
Students distinguish nutrition being technically "covered" from nutrition being meaningfully learned or retained	P2, P4, P7, P10, P11, P12, P13, P14, P15
Nutrition is often remembered as vitamin deficiencies, micronutrients, malabsorption, or board-style biomedical facts rather than practical counseling	P1, P2, P3, P4, P5, P7, P8, P10, P11, P12, P13, P14, P15

Sub-themes	Participant/transcript numbers where discussed
Nutrition is frequently embedded in social determinants, wellness, doctoring, or population health content rather than framed as a core clinical skill	P1, P3, P7, P10, P12, P13, P14, P15
Electives, interest groups, extracurricular activities, or self-directed learning fill gaps left by the formal curriculum	P2, P3, P4, P8, P9, P12, P14, P15
Some schools demonstrate stronger intentional integration of nutrition into the formal curriculum	P6, P10, P15

Theme 2. Assessment drives engagement: students learn what is tested, but testable nutrition does not always match patient-care needs

Sub-Themes	Participant/transcript numbers where discussed
Students prioritize nutrition content when it appears on exams, quizzes, shelves, or required assignments	P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15
When nutrition is not tested or is low-stakes, students often deprioritize it because of information overload	P1, P2, P3, P4, P8, P11, P12, P13, P14, P15
Board-style nutrition is perceived as narrow and focused more on deficiencies or classic associations than patient counseling	P2, P4, P5, P8, P11, P12, P13, P14, P15
In-house exams, intervention-style quiz questions, and required applied assignments can legitimize nutrition education	P1, P6, P7, P10
Interactive, simulation-based experiences may support retention even when not formally tested	P14, P15
Students may value nutrition personally but still struggle to justify spending time on it when it is not assessed	P1, P3, P4, P8, P9, P12, P14, P15
Passive or low-stakes formats can signal that nutrition is peripheral	P2, P3, P4, P9, P14

Theme 3. Students value nutrition but feel underprepared to move from broad advice to individualized counseling

Sub-Themes	Participant/transcript numbers where discussed
Students often feel comfortable asking about diet but less comfortable interpreting responses or giving specific advice	P3, P7, P9, P12, P13, P14, P15
Students can provide general advice but struggle with concrete, patient-specific recommendations	P2, P3, P4, P5, P7, P9, P10, P11, P12, P13, P14, P15
Students often know what patients should avoid, but feel less prepared to answer what patients can realistically eat instead	P2, P4, P9, P10, P12, P13, P14, P15

Sub-Themes	Participant/transcript numbers where discussed
Students identify gaps in practical nutrition skills such as meal planning, carb counting, macronutrient guidance, or condition-specific counseling	P2, P4, P5, P9, P10, P11, P12, P13, P14, P15
Confidence often comes from prior nutrition background, personal experience, extracurricular exposure, or strong clinical role models rather than the formal curriculum	P2, P3, P4, P5, P8, P9, P10, P11, P14, P15
Students feel especially uncertain around diagnosis-specific nutrition counseling	P2, P4, P5, P9, P10, P11, P12, P13, P14, P15
Diet misinformation and patient-led online research are difficult for students to address confidently	P2, P5, P9, P15

Theme 4. Meaningful nutrition counseling requires patient-centered, culturally responsive, and feasibility-based behavior change

Sub-Themes	Participant/transcript numbers where discussed
Effective counseling should begin with the patient's current diet, baseline habits, routines, and household context	P1, P2, P4, P10, P11, P15
Patient readiness, motivation, and willingness to change strongly influence whether counseling feels possible or productive	P1, P2, P9, P10, P11, P15, P16, P17
Students value incremental, realistic goals rather than all-or-nothing advice	P1, P3, P4, P10, P14, P15
Nutrition counseling requires sensitivity because food, weight, and lifestyle are personal and sometimes emotionally charged	P1, P2, P9, P11, P15
Students recognize that food is tied to culture, family, identity, and tradition	P3, P4, P6, P9, P10, P11, P14, P15
Students want culturally tailored substitutions rather than default recommendations that may not fit patients' usual diets	P3, P4, P6, P9, P10, P11, P14, P15
Weight-sensitive counseling should avoid stigma and connect nutrition to health rather than aesthetics	P2
Trust and humility are important when counseling patients, especially when patients bring their own beliefs or information	P1, P2, P5, P15
Counseling should avoid adding stress to patients' already constrained lives	P14, P15

Theme 5. Food insecurity and structural barriers limit what patients can realistically do, making nutrition counseling a team-based and systems-level task

Sub-Themes	Participant/transcript numbers where discussed
Food insecurity, food deserts, and limited food access are common topics in student reflections	P1, P3, P4, P6, P7, P8, P10, P11, P12, P13, P14, P15
Cost, transportation, grocery access, food affordability, and time constraints shape whether dietary recommendations are feasible	P1, P2, P3, P4, P8, P10, P12, P14, P15
Local context matters, especially in border, rural, safety-net, food-desert, and underserved communities	P1, P3, P6, P8, P10, P12, P14, P15
Students are often taught that structural barriers exist, but less consistently taught what to do about them	P1, P2, P3, P7, P8, P12, P13, P14, P15
Referrals and resources may fail when patients are uninsured, resources are outdated, or services are inaccessible	P2, P4, P8, P10, P11, P12, P13, P14, P15
Nutrition counseling can feel discouraging when students see that patients lack the resources to follow recommendations	P2, P8, P10, P12, P15
Students recognize that basic access to food may come before more detailed nutrition counseling	P1, P4, P8, P10, P13, P14, P15
Physical disability, immobility, and visual impairment can limit patients' ability to prepare healthy food	P15

Theme 6. Students see physicians as foundational screeners, counselors, and coordinators — not replacements for dietitians

Sub-Themes	Participant/transcript numbers where discussed
Physicians should be able to initiate broad nutrition conversations and identify diet-related concerns	P2, P3, P4, P5, P11, P13, P14, P15
Physicians should recognize barriers and know when to involve another team member	P1, P2, P3, P4, P5, P8, P11, P13, P14, P15
Dietitians or nutritionists should handle detailed meal planning, complex dietary needs, and specialized nutrition counseling	P2, P3, P4, P5, P6, P10, P11, P13, P14, P15

Sub-Themes	Participant/transcript numbers where discussed
Social workers, community health workers, and resource navigators are important when the issue is access, insurance, SNAP, food pantries, or transportation	P1, P2, P3, P8, P11, P13, P14, P15, P17, P18
Students want physicians to have foundational nutrition competence while also understanding professional limits	P2, P3, P4, P5, P11, P13, P14, P15
Medical students can sometimes serve as bridges by spending more time with patients or translating specialist recommendations into understandable language	P2, P4, P14, P15
Interprofessional role clarity is itself an important educational goal	P1, P2, P3, P4, P5, P6, P11, P13, P14, P15
Some students view advanced or specialty-specific nutrition training as more appropriate for GME, while UME should provide baseline competence for all students	P14

Theme 7. Students recommend integrated, applied, interprofessional nutrition training embedded into existing curricula rather than passive or separate add-ons

Sub-Themes	Participant/transcript numbers where discussed
Students prefer applied learning formats such as cases, workshops, OSCEs, clinical observation, simulations, and real patient examples	P2, P3, P4, P6, P7, P10, P11, P13, P14, P15
Students repeatedly criticize passive modules, podcasts, and click-through assignments as low-engagement	P2, P3, P9, P14
Nutrition should be integrated into existing organ blocks, doctoring courses, PBL/synthesis sessions, clinical skills, or clerkship didactics rather than added as another isolated requirement	P3, P6, P7, P10, P12, P13, P14, P15, P16
Role modeling by attendings, PAs, dietitians, preceptors, or diabetes educators helps students understand how to counsel patients in practice	P2, P4, P8, P10, P11, P15
Students want practice and feedback around motivational interviewing, lifestyle-change conversations, and difficult counseling scenarios	P2, P4, P6, P10, P11, P13, P14, P15

Sub-Themes	Participant/transcript numbers where discussed
Interprofessional training with dietitians, social workers, community health workers, and diabetes educators is viewed as valuable	P1, P2, P3, P4, P6, P8, P10, P11, P13, P14, P15
Resource navigation activities, budget meal planning, food bank exposure, and produce prescription education are promising practical modalities	P1, P3, P8, P10, P12, P13, P14, P15

Additional Supplementary Resources

All additional supplementary materials are referenced in the main text and described briefly. These detailed materials are available on the TNAC website.

- Supplement 1: TNAC Search and Literature Review Strategy
- Supplement 2: Evidence Review and Grading Tables

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