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What's Trending in Evidence-Based Nutrition for 2026

BEYOND PROCESSING: What the Latest Research Reveals About UPFs and Health Outcomes

By Mark Messina, PhD, MS

What you need to know:

- **Lack of consensus on definitions:** Despite rapid growth in research and policy interest, no universally accepted definition of ultra-processed foods (UPFs) exists. The USDA and FDA have solicited input to establish a standardized framework, reflecting the ambiguity surrounding classification systems such as Nova.
- **Evidence of differential health effects:** While total UPF intake has been linked with obesity and adverse health outcomes, these associations are largely driven by specific categories of UPFs (e.g., processed meat and sugary/artificially sweetened drinks). Studies show that nutrient-adequate diets with high UPF content can still be constructed, underscoring the importance of distinguishing nutrient composition from processing.
- **Emerging focus on food constituents:** Recent research highlights that certain markers of UPFs (e.g., flavor enhancers, sweeteners, coloring agents) are associated with increased mortality risk, whereas others are not, which may help industry reformulation of UPFs.

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Despite extensive research on ultra-processed foods (UPFs), no single universally accepted definition of this term exists. In July of this year, the U.S. Department of Agriculture and the U.S. Food and Drug Administration released a request for information (RFI) to assist the government in establishing a uniform definition for UPFs. The RFI outlines six key areas for public comment (Table A). Currently, state legislative bodies use different definitions when enacting legislation related to these foods.

Nova and the Rise of UPFs in Nutrition Research

The term UPF was used even prior to 2009 when Brazilian researchers created the Nova food classification system that included a group of foods referred to as ultra-processed,[1-3] but it is only after Nova rose to prominence that UPFs entered the nutrition lexicon. Nova categorizes foods into one of four groups based on degree of processing and formulation. In 2024, 693 papers on UPFs were indexed in PubMed, representing a six-fold increase

since 2018. Although numerous food classification systems include a category of highly processed foods,[5,8] Nova is the system most used in research.

A Global Issue

The concept of UPFs has been incorporated into dietary guidelines from at least a dozen countries.[4] In contrast, the U.S. Dietary Guidelines Advisory Panel concluded that more study was needed before including recommendations about UPFs in the 2025-2030 Dietary Guidelines for Americans. Even so, Americans are becoming familiar with this term. In 2025, more than 44% of the 1,000 U.S. adults surveyed indicated they are familiar with the term "ultra-processed food," a 12-point jump from 2024.[5] UPFs are commonly perceived as foods that are high in energy, sugar, and sodium, and low in fiber. Online searches for the term "junk food" and UPFs return similar images.

Despite the considerable amount of research conducted on UPFs, the author of a recent commentary in the New England Journal of Medicine concluded that "... adoption of a national nutrition policy focused on Nova – and on UPF, in particular, could do more harm than good, by misguiding consumers and the food industry and imposing costs and burdens on the public...".[6] Forde, a prominent researcher in this field,[7] also recently criticized Nova, saying "Fundamentally, the UPF category doesn't discriminate between foods that are good and bad for us."[8] And, in their recent paper, one of the criticisms lodged by Bernstein et al.[9] against food classification systems based on processing and formulation is the ambiguity in definitions, purpose, and methodology.

There is debate among nutrition scientists about the extent to which the adverse health effects associated with UPFs[10] result from their poor nutritional quality and/or to the poor dietary pattern associated with higher consumption of these foods, as opposed to other inherent properties of UPFs. There is evidence supporting both perspectives.[7,11] Importantly, Hess et al.[11] showed that it is possible to adhere to a diet comprised of ~90% UPFs, still achieve a healthy eating score that is considerably higher than the U.S. average, and contain adequate amounts of most macro- and micronutrients.

Not All UPFs Are Equal: Differential Health Effects

There is no disagreement that foods with vastly different nutrient profiles and overall health attributes are included in the UPF category. This point is evident from a simple comparison of nutrient content as well as the results of observational studies showing that subgroups of UPFs differentially affect health outcomes. Generally, the association between total UPF intake and adverse health outcomes is driven by two categories: processed meats and sugar sweetened beverages.[12,13] These findings emphasize the importance of identifying the characteristics of UPFs that account for their adverse effects, so that consumers can limit their intake of foods with these characteristics and also so that the food industry can consider reformulation to minimize these characteristics. There has been progress toward achieving this goal.

UPF intake has been consistently linked with obesity.[14] UPFs are typically energy dense, (kcal/g) and can be quickly eaten (eating rate, g/min), two attributes that potentially lead to a high energy intake rate (kcal/min), and excess caloric intake and weight gain. A 2019 study by Hall and colleagues[16] found that over just a two-week period, a diet high in UPFs led to a nearly 1 kg gain in body weight whereas there was nearly a 1 kg loss of weight when participants consumed a diet low in UPFs. Participants consumed ~500 kcal/d more when on the high-UPF diet.

The findings by Hall et al.[16] are consistent with research by Lasschuijt et al.,[17] who compared the effects on caloric intake of four meals that varied in eating rate (slow or fast) and energy density (3.8 vs. 1.9 kcal/g). Participants consumed ~50% fewer calories (570 kcal vs. 1143 kcal) when eating the low energy density, slow eating rate meal in comparison to the high energy density, fast eating rate meal. In alignment, when study participants were provided with two eight-week ad libitum diets following the UK Eatwell Guide, weight loss was twice as great on the pattern built around minimally processed food compared to meals that incorporated UPFs, although subjects experienced weight loss on both plans.[15]

Eating rate is determined primarily by texture and energy density. Energy density, which played the biggest role in the increased caloric intake in the study by Lasschuijt et al.,[17] is determined primarily by fiber, water, and fat content. The importance of energy density and eating rate indicates that nutrient content remains a crucial factor in the health impact of UPFs. Finally, Finlayson et al.[16] recently set out to determine the nutritional, sensory, and cognitive characteristics and attributes of foods that impact food reward-related outcomes. Based on their three studies, they concluded that whether a food is ultra-processed has a negligible influence on self-reported food liking and hedonic overeating.

Nevertheless, there may be constituents common to UPFs that impact health in ways not fully understood. Recent-

ly published research provides unique insight into the constituents of UPFs that possibly contribute to their adverse health effects. Krost et al.[17] examined the relationship between the intake of 37 markers of ultra-processed foods (MUPs) and mortality among participants in the UK Biobank. MUPs are food ingredients that include cosmetic additives, such as flavor agents, coloring agents, and sweeteners, and nonculinary ingredients, such as fructose, modified oil, and isolated protein. If at least one MUP is found in a food item, it is considered a UPF.

Over a mean follow-up of 11.0 years, 10,203 deaths occurred among the 186,744 participants. After adjustment for a range of potential confounders, five MUP categories were significantly associated with mortality: flavor agents, flavor enhancers, coloring agents, sweeteners, and varieties of sugar. In addition, 12 specific MUPs were positively associated with all-cause mortality: glutamate, ribonucleotide, acesulfame, saccharin, sucralose, caking agent, firming agent, thickener, fructose, inverted sugar, lactose, and maltodextrin. One MUP gelling agent was inversely related to mortality. A total of 20 specific MUPs, including interesterified fat, fiber, and protein isolates, were unrelated to risk. Adjustment for diet quality did not substantially alter the results. Krost et al.[17] recommended that intervention studies focus on the MUPs associated with harmful effects.

Despite the adjustments made, these findings on MUPs stem from an observational study, so it would be premature to conclude—without substantial clinical evidence—that any of the identified MUPs should be avoided. The work by Krost et al. simply highlights that if certain UPFs negatively affect health independent of nutrient content, understanding the underlying reasons is important, as such insights could inform future product reformulation.

Moving Forward: Refining Definitions and Research Priorities

In summary, several lines of evidence challenge the utility of the Nova food classification system for serving as a guide for consumer food purchasing decisions. Observational studies indicate that foods Nova-classified as ultra-processed differentially affect health outcomes. Recent research highlights the characteristics of foods that are likely to contribute to excessive caloric intake. More research is needed to determine whether there are characteristics common to ultra-processed foods independent of nutrient content that contribute to their reported adverse health outcomes.

Table A: U.S. Food and Drug Administration RFI for public comment

1. **Classification Systems:** Input is sought on existing classification systems and their applicability to the U.S. context, including benefits and limitations.
2. **Ingredient Labeling:** Comments are requested on how ingredient prominence and function (e.g., flavorings, colorings, preservatives) should influence UPF classification.
3. **Processing Methods:** The RFI explores how physical, biological and chemical processing techniques (e.g., extrusion, fermentation, pH adjustment) may define UPFs.
4. **Terminology:** Stakeholders are asked whether "ultra-processed" is the most appropriate term or if alternatives would better capture public health concerns.
5. **Nutritional and Sensory Attributes:** The agencies seek views on incorporating factors like energy density, palatability, and nutrient composition into a UPF definition.
6. **Operationalization:** The RFI requests ideas on how to systematically apply a UPF classification in food labeling, research, and policy.

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PLANT-BASED MEAT ALTERNATIVES PROVIDE A PRACTICAL, NUTRITIONALLY SOUND WAY TO BOOST PLANT PROTEIN INTAKE

By Virginia Messina, MPH, RD

What you need to know:

- **Legumes are nutrient-dense but under-consumed:** Despite being economical sources of protein, fiber, and micronutrients, legumes contribute minimally to U.S. and global protein intake due to barriers such as preparation time and perceived tolerance issues.
- **Plant-based meat alternatives (PBMAs) offer a practical substitute:** While classified by Nova as ultra-processed, evidence indicates PBMAs do not carry the same health risks as other ultra-processed foods and likely provide benefits for those seeking to increase plant protein intake.
- **Nutritional impact depends on formulation:** PBMAs vary in nutrient content (e.g., sodium, fortification levels) but overall can help improve the plant-to-animal protein ratio when incorporated a few times per week.

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In the early part of the 20th century, Americans consumed approximately equal amounts of plant and animal protein, according to disappearance data from that period.[9] Today, however, populations in high-income countries, including the United States, derive twice as much protein from animal food as from plants.[6,7] Efforts to shift towards more plant protein in these countries reflect growing concerns about both environmental[1,2] and health[3-5] impacts of different protein-rich foods. There is also a need to identify more healthful sources of plant protein since, in the U.S., the major contributor of plant protein to the diet is refined grains.[8]

The Nutritional Value of Legumes

Legumes, such as soybeans and pulses, which include dry beans and lentils, represent a healthy, economical, and sustainable source of plant protein. These foods are unique in that they provide both protein and fiber – a 100g serving of cooked dry beans provides >8g protein and >7g fiber[10] – making them an especially valuable addition to the diet for Americans who consume roughly half the recommended fiber intake.[11] In addition, legumes are good sources of several vitamins and minerals.[10]

Low Legume Intake in the U.S. and Globally

Legumes remain greatly underutilized in American diets. According to an analysis of the National Health and Nutrition Examination Survey (1999-2016), Americans get only about 2% of total protein and 6% of plant protein from legumes,[8] with little change over the past 20 years. Globally, intake is somewhat higher but still modest, providing just 6% of protein worldwide although consumption varies regionally.[12] Average global pulse consumption is only 21g per capita per day, without change over the past three decades, according to the Food and Agriculture Organization.[12] Barriers to greater consumption include the time and effort required for preparation and the gastrointestinal disturbances experienced by some individuals when first incorporating legumes into their diet.[13] Even with major public health initiatives, it is unlikely legume intake will substantially increase in the near future.

Rise of Plant-Based Meat Alternatives (PBMAs)

Plant-based meat alternatives (PBMAs) derived from legumes offer a promising and convenient way to increase plant protein intake beyond traditional legume preparations. Plant protein-rich foods, such as tofu and tempeh, have been consumed in place of meat for centuries. Products designed to more closely mimic meat, and often

made from soy or peanuts, have been available for more than 100 years. Recently, a new generation of PBMAs has entered the market. These PBMAs have been created to more closely mimic the organoleptic properties – the taste and texture of meat – than earlier iterations. They are typically comprised of a concentrated protein source, usually pea, soy or wheat, along with fat, binding and flavoring agents, and colorants.

This new generation of PBMAs was initially met with enthusiasm, and became widely available in grocery stores and restaurants, including fast food chains. However, more recently, the industry has faced challenges, including higher costs, a trend toward the promotion of meat consumption by some social media wellness influencers, and, most importantly, concerns about the processed nature of PBMAs.[14]

PBMAs and the Ultra-Processed Food Debate

Many food classification systems include a category of highly processed or ultra-processed foods (UPFs),[15,16] but the Nova food classification system, developed in 2009, is the one used most often to define UPFs in research settings.[15,16] Nova classifies any food using a concentrated source of protein as ultra-processed.

Although total UPF intake is associated with a range of adverse health outcomes,[17] this does not mean that PBMAs should be avoided. Notably, Nova's list of UPFs includes a wide range of dissimilar foods that includes everything from pastries to flavored yogurt (a food that has earned eligibility for a qualified health claim and reduced risk of type 2 diabetes, according to limited scientific evidence).[18] While observational studies consistently link total UPF intake to adverse health effects,[17] subgroups of UPFs have differentially affected health outcomes. Much of the association between total UPF intake and adverse health is driven by a few subcategories, especially processed meat and sugar-sweetened beverages.

In contrast, PBMAs are typically not associated with increased risks – a point recently recognized by the Scientific Advisory Committee on Nutrition in the UK[19] – and are sometimes associated with benefits. For example, an analysis of the UK Biobank data found a higher total UPF consumption was associated with a shorter leukocyte telomere length (LTL) (a shorter LTL is reflective of aging), whereas intake of vegetarian alternative UPFs such as PBMAs was associated with longer LTL.[20]

Clinical Research Suggests PBMA Health Benefits

Clinical research provides evidence that PBMAs can support health and help allay concerns. A Stanford University study by Crimarco et al.[21] found that in comparison to meat, PBMAs reduced body weight, LDL cholesterol, and trimethylamine oxide levels, a putative cardiovascular disease risk factor. For this study, participants in random order consumed either ~2.5 servings/day of meat or PBMAs for eight weeks and then switched to the opposite diet.

In contrast to the results of this study, a similarly designed study in Singapore[22] failed to find differences in a range of health outcomes between meat and PBMAs. The researchers responsible for this work cited differences in the nutrient content of the PBMAs used in their study versus the Stanford study as reasons for the differing findings. This highlights the importance of nutrient content, rather than the extent of processing. Notably, even in the Singapore study, PBMAs – despite their Nova classification as ultra-processed – did not perform worse than meat.

Comparing PBMAs with Meat Products

UPFs are generally less healthy versions of the relatively healthy foods they are intended to replace. For example, ultra-processed chicken nuggets often replace less processed forms of chicken. In contrast, plant-based burgers serve as a replacement for red meat and processed meat.

It can be argued that the ideal replacement for red and processed meat is whole legumes, but since these foods have met some resistance among consumers, PBMAs remain a reasonable alternative. In addition, PBMAs have the advantage of potentially being fortified with an array of shortfall nutrients in plant-based diets.

A Practical Path to Balanced Protein Intake

PBMAs differ quite markedly in nutrient content, depending upon the protein and fat sources and especially the level of vitamin and mineral fortification. It is important to consider these factors when using PBMAs as a main source of protein, particularly since some products are relatively high in sodium.[23] Overall, however, the evidence indicates that in high-income countries, PBMAs represent a nutritionally sound and convenient way to increase plant protein intake. In most instances, consuming just four or five servings of PBMAs per week can bring the plant to animal protein ratio of the diet to approximately 1:1.[24]

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SNACKABLE INSIGHTS by Mark Messina, PhD, MS

CAN PATIENTS WITH CELIAC DISEASE SAFELY CONSUME SOY? WHAT THE EVIDENCE SHOWS

By Mark Messina, PhD, MS

Celiac disease (CD) is an autoimmune enteropathy triggered by dietary gluten in genetically susceptible individuals. Gluten is commonly present in cereals such as wheat, barley, rye, and spelt.[1] The prevalence of CD has steadily increased in the latter half of the 20th century and into the 21st century.[2] The increased incidence of CD noted globally, has also been observed in the U.S.[3] Estimates are that global prevalence ranges from between 0.7% and 2.9% in the general population. Prevalence is higher in females and well-defined at-risk groups, such as relatives of affected individuals and patients with autoimmune comorbidities.[4] In addition to CD, non-celiac gluten sensitivity (NCGS) has been estimated to have a U.S. prevalence of up to 6%.[5] NCGS is a clinical entity characterized by the absence of CD and wheat allergy in patients that trigger reproducible symptomatic responses to gluten-containing foods.

Soybeans do not contain gluten. Nevertheless, there is confusion about whether patients with CD can consume soy foods. At least two observations are likely to contribute to this confusion. Most traditional soy sauces contain gluten as they are made from wheat, soybeans, salt, and water. However, some gluten-free soy sauce options are available. Interestingly, a 2018 analysis found that despite being made with wheat, the presence of gluten in soy sauce was undetectable, perhaps because the protein was hydrolyzed during fermentation.[6]

In 1999, Faulkner-Hogg et al.[7] reported that consuming soy triggered symptoms in CD patients after they followed a strict gluten-free diet. In fact, of the 24 patients examined, 12 reacted to soy. A decade ago, one author reported in personal correspondence that, although no follow-up studies had been published, clinical experience still indicated that soy triggers symptoms in CD patients. However, in contrast to this report, a 2019 study found that in pediatric patients with both CD and eosinophilic esophagitis, soy was well tolerated, which led the authors to conclude that reintroducing this food first, or trialing a soy-inclusive elimination diet, is a viable treatment strategy.[8]

These contrasting findings may be a result of possible cross-contact of soy flour with wheat. In 2010, Thompson et al.[9] found that of the two soy flours analyzed, one contained only 92 parts per million gluten, whereas the

other contained 2,925 parts per million. These values indicate the potentially huge variation in gluten cross-contact within the same product category, and that some soy products may cause reactions in patients with CD. For comparison, <20 parts per million is generally considered "gluten-free" according to the U.S. FDA.[10] Finally, it is possible that some CD patients are also allergic to soy protein, although the incidence of soy allergy is quite low in comparison to the other major food allergens.[11]

Before that 2010 publication, Haeney et al.[12] reported that CD patients who responded poorly to a gluten-free diet had significant anti-soya antibodies in comparison to patients with other gastrointestinal diseases. These authors suggested that CD patients may have an associated dietary soy sensitivity which could adversely influence their response to gluten withdrawal.

Practical Guidance for Patients and Clients

So, what might account for some CD patients reacting to soy? There are several possibilities, but one of the most likely is cross-contact. Comingling of grain can occur because of the use of shared harvesting, transporting, and processing equipment.[13] Soybeans are typically rotated with other crops to improve soil conditions, one of which is wheat.[14]

If you have CD, and are concerned about consuming soy products, look for products labeled or certified as gluten-free.

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RETHINKING THE OMEGA-6 TO OMEGA-3 RATIO: Balance vs. Adequacy

By Mark Messina, PhD, MS

Research published beginning in the early 1990s led to a consensus within the field of nutrition that the dietary ratio of omega-6 to omega-3 polyunsaturated fatty acids (PUFAs) was a measure of diet quality. The essential PUFAs linoleic acid (LA) and alpha-linolenic acid (ALA) are the primary dietary omega-6 and omega-3 PUFAs. It was hypothesized that a high LA to ALA ratio induces a pro-inflammatory state through LA's conversion to arachidonic acid and subsequent eicosanoid production. However, a large amount of clinical and observational research suggests there are several reasons to doubt how useful the omega-6 to omega-3 ratio really is.

Not only does LA intake have little to no bearing on blood or tissue levels of arachidonic acid,[1] but some of the eicosanoid mediators produced from this fatty acid are anti-inflammatory.[2] LA intake may still affect the conversion of ALA into the long-chain omega-3 PUFAs eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are linked to various health benefits. Since LA and ALA share a single set of enzymes for elongation, they compete for access. However, while increasing ALA intake does increase circulating and tissue levels of EPA,[3-10] there is little increase in DHA levels because the endogenous conversion of EPA into DHA is so minimal.[11] For example, one study found that decreasing the LA content of the diet from 7.4% of energy, which approximates current U.S. intake, to 2.4% of energy (which is barely sufficient to avoid deficiency of this fatty acid) led to a 33% increase in EPA but only a 9% increase in DHA.[12] Since both longer chain omega-3 fatty acids are beneficial, the small increase in DHA would hardly justify such a dramatic dietary change, even if such a change were feasible. Furthermore, higher LA intake is associated with a range of health benefits, including lowering circulating cholesterol levels and risk of coronary artery disease.[13]

Practical Guidance for Patients and Clients

Since both omega-6 and omega-3 fatty acids offer health benefits, the focus should be on consuming adequate amounts of each. In the U.S., omega-6 fatty acid intake is optimal with nutritional recommendations, but omega-3 fatty acid is lacking. Omega-3 fatty acids are found in certain types of fish such as salmon and mackerel and supplements derived from these fish. For vegetarians, omega-3 fatty acid supplements derived from algae are available.

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U.S. HEALTH PROFESSIONAL SURVEY REVEALS SURPRISING PROTEIN PREFERENCES AND PERCEPTIONS

By Mark Messina, PhD, MS

In the United Soybean Board's recent survey, U.S. health professionals identified beans and lentils as their top-rated protein sources, offering insights worth further exploration. These findings align well with nutrient content, given their combination of protein and fiber, though less so with actual consumption, as U.S. intake of these foods remains relatively low. Eggs ranked second, followed by nuts and seeds. While nuts and seeds contribute valuable nutrients, they are not typically considered high-protein foods (peanuts are a notable exception since they are botanically classified as legumes and are good sources of protein).

More than 75% of respondents rated tofu and soy highly, yet pea protein isolate edged out soy protein isolate in ratings – even though soy scores better on key protein quality measures.

Soy burgers and soy-based meat alternatives appeared further down the list, with their favorability scores declining over the past three years (63% in 2023, 57% in 2024, and 51% in 2025). This trend may reflect growing attention to the topic of ultra-processed foods. Food classification systems ostensibly based solely on processing (such as Nova) categorize any product made with a concentrated source of protein, such as plant-based meat alternatives, as ultra-processed. Consistent with this, survey responses show that the perception of soy-based meat alternatives as "processed" has increased from 55% in 2023, to 65% in 2025. While these perceptions align, both clinical and observational research increasingly challenges the utility of categorizing foods based on processing. Such classification can overlook the strong protein contributions these products provide.

Finally, the survey highlighted some differences between health professionals and the clients/patients they serve. Consumers often express concerns about soy and breast cancer risk, whereas health professionals familiar with the body of evidence generally do not share this concern. Conversely, health professionals voiced more caution about the genetic modification of foods than consumers. This contrast underscores the value of ongoing dialogue and evidence-based communication, including patient-facing resources, around these topics.

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SOY CONSUMPTION TRENDS IN JAPAN: Implications for Interpreting Health Outcomes and Setting Intake Recommendations

By Mark Messina, PhD, MS

Soy intake among populations with a long history of soy consumption is often used to guide recommendations for non-Asians and cited as partial evidence of health benefits. There is no dispute that historical rates of breast cancer in Japan and China are remarkably lower than U.S. rates. However, these kinds of ecological observations are valuable only for generating hypotheses, not for reaching conclusions. The question is not whether Japan or any other country has or had a lower rate than the U.S., but rather, whether women who regularly consume soy have lower rates of breast cancer than women who consume soy infrequently (they do, by the way).[1]

Nevertheless, it is reasonable to use soy consumption by populations for whom soy foods are a traditional food for making intake recommendations for non-Asians, especially with respect to upper intake limits. But such recommendations should be made cautiously because of the possible differences in response to soy among different ethnicities.

With this background in mind, it is important to recognize that as the Japanese diet has become more "Westernized," soy protein intake has decreased. For example, based on disappearance data, soy protein intake decreased from 9.7 g/day in 1961 to 8.4 g/day in 1977.[2] Although that decrease is relatively minor, when expressed as a percentage of total protein, soy protein intake decreased from 13.4% in 1961 to 9.5% in 2002. That decrease occurred primarily due to an increase in animal protein intake. The change in soy consumption is also illustrated by the difference in intake according to age. In a paper published last year, women aged 50 to 59 years consumed "soy" 7.3 times per week versus 5.2 times for those 20-29 (Table A).[3] This decreased intake may make it increasingly difficult for observational studies to provide insight into the possible health effects of soy. As a result, recommendations will have to be based entirely on clinical research.

Table A: Soy intake among women in Japan according to age

Age	n	Frequency (x/ week) (mean ± SD)
20-29	1091	5.2 ± 0.1
30-39	399	6.0 ± 0.2
40-49	383	6.8 ± 0.2
50-59	306	7.3 ± 0.3

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