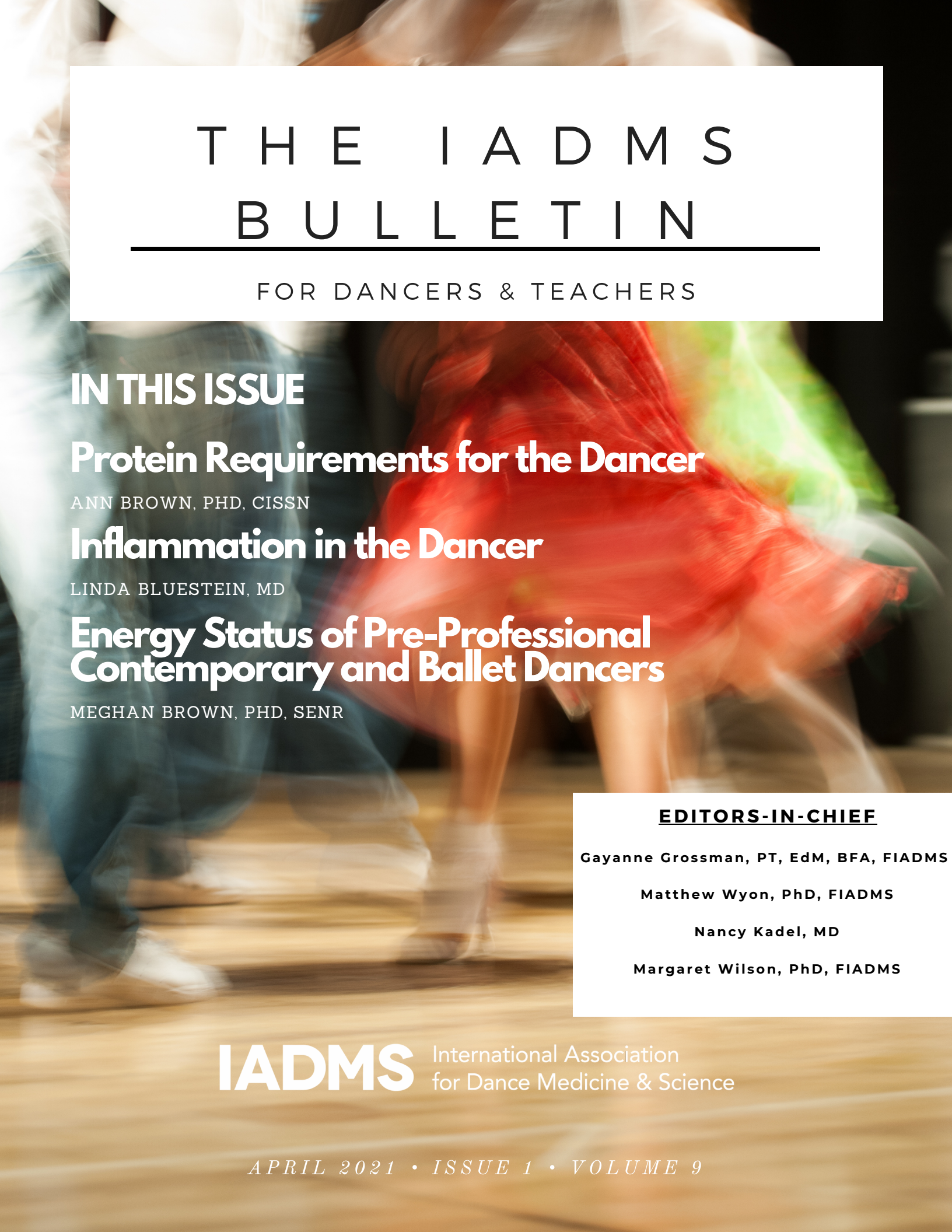

THE IADMS BULLETIN

FOR DANCERS & TEACHERS

IN THIS ISSUE

IADMS International Association for Dance Medicine & Science

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WELCOME

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LETTER FROM THE EDITORS

Dear Dancers and Teachers,

IADMS Bulletin for Dancers and Teachers is grateful to our readers for their interest in bringing dance science to studio and performance practice. As always, thank you to Ken Edelman and Balanced Body for the ongoing support that makes this publication possible.

We are excited to invite you to our new modernized, fun, and updated look to the IADMS Bulletin, to go with our new website. Check it out when you have a chance at www.iadms.org.

This issue of the IADMS Bulletin for Dancers and Teachers looks at different aspects of nutrition and energy balance, fundamental and vital areas for dancers throughout their dance journey. Researchers Meghan Brown PhD, Ann Brown PhD, and Linda Bluestein MD have graciously shared their wisdom and written these articles for us. We always welcome your comments and input.

Our email is Bulletin@IADMS.org.

Sincerely,
Gayanne Grossman, PT, EdM, BFA, FIADMS
Matt Wyon, PhD, FIADMS
Nancy Kadel, MD
Margaret Wilson, PhD, FIADMS

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PROTEIN REQUIREMENTS FOR THE DANCER: CONSIDERATIONS FOR ALL DIETS

ANN BROWN, PHD, CISSN

Protein recommendations vary across populations due to differing activity levels, personal goals, and dietary preferences. To meet basic nutrition requirements, the average adult is recommended to consume 0.8 grams per kilogram of body weight per day (g/kg/day). This guide is known as the Recommended Dietary Allowance (RDA) which was created in order to provide a recommendation to meet physiological requirements of most all healthy persons. The RDA recommendation for protein represents the estimated average requirement determined from nitrogen balance (protein loss = protein intake) studies which identified the minimal dietary protein needed to avoid negative protein balance (protein loss > protein intake). Proteins have numerous functions in the body required for proper structure and function of tissues and organs. Therefore, when negative protein balance occurs, the body no longer has sufficient protein stores for optimal function.

Dietary protein provides the necessary nutrients to synthesize contractile proteins in muscle as well as proteins in tendons and bone. Research has consistently shown increases in muscle protein synthesis and sensitivity to protein consumption allowing for muscle growth following a bout of exercise. It is critical to recognize that the RDA was established to provide ***minimal*** protein needs for an average healthy person, not a highly active, aesthetic athlete. In a dance population where activity level is high and dancers strive for optimal aesthetics, performance, and health, protein recommendations are dramatically increased. Dancers have previously been recommended to consume 1.2-1.7 g/kg/day (2x the RDA), however, more recent research has shown beneficial effects on body composition when protein is increased to as high as 2.3 g/kg/day (almost 3x the RDA).

There are inherent issues with dietary self-report. However, it is the simplest way to understand dietary consumption and should be used to provide assessment and recommendations while accounting for possible intentional or unintentional error in reporting. In the collegiate dancer population, dancers reportedly consume a wide range of habitual dietary protein starting as low as 0.6 g/kg/day to as high as 2.0 g/kg/day. This range represents individual differences, but also variability in the diet from day to day. In terms of the diet as a whole, this is approximately 7-18% of total caloric consumption (12-15% recommended for dancers). Although research indicates that some dancers fall within the recommended ranges for protein intake, the low end of these ranges is concerning, and dancers should pay particular attention to protein sources in their diet. In dietary analyses, dancers have reported consuming protein from items such as meat, fish, cheese, milk, beans, quinoa, and nuts/seeds. These sources of protein, however, are not created equally. Animal-based proteins are considered complete proteins because they contain all essential building blocks (amino acids) needed in the diet. Plant-based proteins are considered incomplete proteins because they do not contain all essential amino acids needed in the diet. Conveniently though, two plant-based proteins, such as rice and beans, can be consumed together to create a complete protein and provide all essential amino acids. In simpler terms, multiple plant products can provide the same protein profile as one animal product. Consuming all dietary protein through plants is possible, however it may take substantial effort to ensure the recommended amount (grams) and quality of protein (all essential amino acids) are consumed regularly.

Protein supplementation has been successful and well-tolerated in many athletic populations including dancers. However, there does appear to be a ceiling with protein supplementation. One previous study supplemented up to 4.4 g/kg/day and observed no difference in body composition compared to consuming 2.3 g/kg/day. In short, 5x the RDA is no different than 3x the RDA and there appear to be diminishing returns on body composition and performance. In aesthetic sports, where body weight/composition is a critical component to success, protein supplementation has been shown to aid in attenuation of muscle mass loss during weight loss or energy restriction. However, in order to capitalize on the benefits of protein, dancers need to pay close attention to protein sources from both whole foods and supplements because all essential amino acids are required for muscle protein synthesis.

Although it may be easier to reap the benefits from protein by consuming animal products, dancers can gain the same benefits through plant proteins if done correctly. Supplementation may be a key strategy for a plant-based dancer to consume the recommended amount of protein. If supplementation is of interest to the plant-based dancer, then there needs to be extra focus on identifying a supplement that has an appropriate amino acid concentration to stimulate muscle protein synthesis. As mentioned previously, not all proteins have the same amino acid profile. Therefore, it is highly suggested that vegetarian or vegan dancers supplement with a combination of plant-based proteins (oat and pea protein) to provide similar protein characteristics as animal-based proteins such as whey or casein.

Essential amino acid profile, and more specifically, leucine content, is substantially lower in plant-based diets. Leucine is known as the most potent stimulator of muscle protein synthesis and therefore, has become the most popular amino acid. Low leucine content in plant-based foods is the primary reason for reduced muscle protein synthesis following supplementation when compared to an animal source. If following a plant-based diet, the dancer will need to consume substantially more food in order to achieve minimum leucine content (2.7 g) and stimulate muscle protein synthesis. For example, to achieve 2.7 g of leucine, someone would need to consume 25 g of whey protein or 47 g of oat protein. In order to achieve an equal leucine dose, almost double the amount of oat protein is needed compared to whey. Dancers are encouraged to follow any well-balanced diet of their choice so long as protein quantity and quality are both meeting recommendations.

In order to maintain a lean aesthetic in a healthy manner, sustain positive nitrogen balance and optimize muscular performance, dancers should strive to consume 1.5-2.3 g/kg/day of protein no matter what food choices the dancer prefers. Protein recommendations can be met simply by consuming whole foods. Protein supplemntation

"Protein recommendations can be met simply by consuming whole foods."

is not always necessary. However, for those dancers choosing to follow a diet where animal products are minimally consumed or completely excluded (vegetarian, pescatarian, vegan, etc.) protein intake should be closely monitored and supplementation may provide a simple solution to reach protein recommendations. Most importantly, it is advised to first attempt to meet nutrition recommendations through a quality balanced diet prior to resorting to supplementation. This wider protein recommendation range (1.5-2.3 g/kg/day) allows for variability between days that differ in training intensity, individual goals (increase muscle mass, reduce fat mass, etc.) and personal dietary choices (meat-based vs. plant-based).

RELATED RESEARCH FOR FURTHER READING:

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INFLAMMATION IN THE DANCER: LOWERING CHRONIC INFLAMMATION TO IMPROVE PERFORMANCE AND OPTIMIZE CAREER LONGEVITY

LINDA BLUESTEIN, MD

Photo Credit: Mikaela Kelly

"A HEALTHY OUTSIDE STARTS FROM THE INSIDE"
-ROBERT URICH

Healthy lifestyle choices can help you feel better, dance better, and heal faster. The small choices the dancer makes each and every day can have a significant influence on overall health. Since all bodily systems are connected, even slight changes can make a significant difference. One large study(1) showed that people had a 78% lower risk of developing a chronic disease (diabetes, heart attack, stroke, and cancer) when they reported four healthy lifestyle factors. These included: never smoking; physical activity for at least 3.5 hours a week; non-obese Body Mass Index (BMI); and eating a healthy diet (vegetables, fruits, whole grain bread, and low quantities of meat). What do these four diseases mentioned above have in common? They are all correlated with high levels of systemic (meaning throughout the body) chronic inflammation (SCI). Some dancers are genetically predisposed towards having more inflammation than others. Although we cannot change our genetics, we change how our genes are expressed through our lifestyle choices and environment.

BUT ISN'T INFLAMMATION NECESSARY?

The immune system responds to bodily threats by creating inflammation; it protects itself from infection, injury, or stress by increasing blood flow and bringing immune-enhancing cells to areas of the body or brain that require healing. After the damage is repaired, the inflammation normally goes away, but that is not always the case. Recurrent infections, nutrient imbalances or deficiencies, emotional stress, or lack of sleep are examples of things that can keep inflammation high. Inflammation can be acute or chronic. After you sprain your ankle, it may become red and swollen; this is an example of acute inflammation, which is self-limiting and a desirable response to an injury. Chronic inflammation, on the other hand, is undesirable and can cause tissue damage. It is correlated with numerous chronic diseases involving nearly every system of the body. By lowering levels of chronic inflammation, you may improve your health. Conditions that include "-itis" also involve inflammation, for example, arthritis is inflammation of the joints and gingivitis is inflammation of the gums.

Inflammatory activity is dynamic and is responsive to lifestyle changes. Standard blood tests for inflammation can be measured but are not always reliable tools for detecting levels of inflammation in the body. There are numerous symptoms (Fig 1) and pain, fatigue, insomnia, and mood disorders may be indicators of elevated levels of chronic inflammation.

Making lifestyle changes to lower chronic levels of inflammation is helpful since addressing the root cause(s) of illness can benefit the entire body. Traditional medical approaches typically involve making a diagnosis and then prescribing drugs or procedures to treat that specific condition. Sometimes there is a modifiable lifestyle factor contributing to the medical problem that could impact a dancer's need for medication; for example, if a dancer with mild asthma stops smoking, they may no longer need to take a daily inhaler medication because they have removed one of the underlying triggers of their asthma. Of course, the dancer always needs to work with their own healthcare providers before making any changes to their treatment protocol. As mentioned above, injuries can lead to persistent inflammation. Whether the injury is acute or due to overuse, it should be taken care of promptly to allow the body to recover more quickly. Taking proper care of acute injuries also decreases the risk of developing persistent or chronic pain. A proper medical evaluation should also be performed (ideally by professionals trained in dance medicine). The dancer's recovery may be optimized by utilizing a multidisciplinary team.

- Body pain, joint pain, muscle pain
- Chronic fatigue and insomnia
- Depression, anxiety and mood disorders
- Gastrointestinal complications like constipation, diarrhea, and acid reflux
- Weight gain or weight loss
- Frequent infections

FIGURE 1: SIGNS AND SYMPTOMS OF CHRONIC INFLAMMATION

Lowering levels of chronic inflammation in the body impacts how the dancer's body feels and functions especially when it's present in the central nervous system (the brain and spinal cord), which is called neuroinflammation. Lowering levels of inflammation in the nervous system even slightly has significant impacts. Neuroinflammation is believed to be a primary driver for chronic widespread pain (e.g. fibromyalgia). Hypermobility disorders (such as Ehlers-Danlos Syndromes and hypermobility spectrum disorders) are also often associated with pain and inflammation. These conditions are more prevalent amongst dancers due to the aesthetic benefits from increased joint range of motion. Lifestyle approaches to decreasing inflammation are helpful for any persistently painful condition.

Reducing levels of physical and psychological stress benefits the body in numerous ways. The mind and body are intricately linked via physiological mechanisms. Levels of social support, social conflict, and other stressors impact inflammation directly through the nervous system as well as indirectly due to potential depression and detrimental health behaviors. Spending time with family and friends, even if virtually, is truly good for our health. When stress is perceived, our brain stimulates the release of cortisol (an important regulatory hormone) from the adrenal glands. Chronic stress causes cortisol levels to be continually elevated. This can lead to excessive abdominal weight (apple shape) and chronically elevated sugar levels. The immune system also becomes over activated and key immune functions are suppressed; this increases the risk for infections, slower wound healing, and faster aging.

BUT THIS CAN BE REVERSED!

Healthy management of stress using strategies like mindfulness and meditation can have positive effects on the body. Multitasking while eating and eating quickly should be avoided when possible. Improving poor sleep, if present, decreases chronic inflammation. Avoid smoking and vaping (electronic cigarettes) since they increase the risk of systemic chronic inflammation (SCI). Cigarette smoking impairs immunity, increases autoimmunity (conditions where the body confuses self vs non-self), and increases gum disease and cancer risk. Smoking also slows the rate of healing by multiple mechanisms, including reducing the rate of oxygen delivery to tissues and impairing collagen synthesis. Quitting smoking, or cutting back even by a small amount, will improve the healing process and levels of inflammation.

IS YOUR DIET NUTRIENT DENSE OR NUTRIENT POOR?

Our body needs appropriate amounts of both macronutrients (carbohydrates, protein, and fat) and micronutrients (vitamins, minerals, enzymes, and antioxidants) to function properly and our food choices are the most impactful decisions we make. A healthy diet (the kinds of foods a dancer eats regularly) is our best tool against chronic inflammation. Every time we eat, we change the chemical composition of our body and either decrease or increase inflammation. Many people

TABLE 1: HIGHLY PROINFLAMMATORY AND ANTI-INFLAMMATORY FOODS

Highly proinflammatory foods	Anti-inflammatory foods
Sugar and high fructose corn syrup	Healthy fats (e.g. avocado, nuts, and fatty fish like salmon, mackerel, tuna, and sardines)
Trans-fats (e.g. French fries and other fried foods)	Fruits (e.g. strawberries, blueberries, cherries, and oranges)
Refined carbohydrates (white flour products)	Green leafy vegetables (e.g. kale, spinach, and collards)
Excessive alcohol	Lean protein sources (e.g., beans, quinoa, eggs, and chicken)
Red and processed meat	Olive oil
Omega-6 oils (e.g. vegetable oils, margarine, shortening and lard)	Tomatoes
Salt	

consume a suboptimal diet; these are typically low in fruits, vegetables, fiber, and prebiotic rich foods and high in refined grains, alcohol, and processed foods. These foods negatively alter the microorganisms that live in our gastrointestinal tract (the gut microbiome). There are hundreds of different species of bacteria present in our gut and each plays a different role in the body, and the microbiome composition is critically important for proper immune function and brain health. Refined grains and sugar (common in processed foods) increase oxidative stress and SCI. High proinflammatory and anti-inflammatory foods are listed in Table 1.

Food scientists take full advantage of the three major human taste pleasures (salt, sugar, and fat) to sell more products; the fast-food and processed food industries combine these components to create "hyperpalatable foods". These highly engineered foods activate the pleasure-reward circuitry in the brain making people consume more and more. Cooking foods at high temperature and in low-humidity conditions also leads to appetite stimulation, overeating, obesity and SCI. These intentionally irresistible and non-nutritious foods can change cellular metabolism and amplify the inflammatory response. The "Western Diet" has unfortunately spread throughout the world leading to a greater consumption of grains and processed foods. Some studies have shown that junk food makes up 1/3 of the average American diet. These high glycemic foods (sugar and processed foods) spike blood sugar quickly resulting in a reactive drop in blood sugar, food cravings, and increased inflammation. Processed foods, sugar, meat, and dairy also lower the pH of the body whereas green vegetables, lentils, and most fruits raise it. Enzymes work more efficiently in the body when an optimal pH is maintained.

Sugar is found in almost all foods and goes by many names (fructose, glucose, corn, syrup, honey, and sucrose are just a few). Most people have no idea how much sugar they truly consume because there are so many hidden sources. Americans consume the most sugar (almost ¼ of a pound daily – more than 10 times the lowest recommendation). In order, Germany, Netherlands, Ireland, Australia, Belgium, United Kingdom, Mexico, Finland, and Canada complete the remainder of the top ten list. Sugar is the king of inflammation and processed foods containing added sugar can also cause insulin resistance. Consuming less sugar, in all forms, is a crucial step in lowering inflammation. Desensitization to sweets occurs when we over ingest them; if we remove sweets from the diet for a week or so, our pallet can reregulate leading to less intake of sweeteners of all kinds. This holds true for salt as well. Caffeine consumption is important to assess especially if they include sugar and sugar-laden non-dairy creamers as these are proinflammatory. If you need caffeine to get going each day, perhaps working on improved sleep and stress management would be beneficial. Excessive amounts of caffeine can also increase insulin secretion, increasing cravings for sugar and refined carbohydrates.

Up to 20% of the population has food intolerances(4), there are key differences between food allergies which have an immune basis and food intolerances which do not. Adverse food reactions may include gastrointestinal symptoms but may also include symptoms elsewhere in the body. Some of the more common culprits for non-allergic food sensitives include the FODMAPs'. These are fermentable carbohydrates (or sugars) which are often poorly absorbed and may lead to increased water and gas in the bowel triggering symptoms in susceptible people. A low FODMAP diet involves reducing intake of certain problematic foods and has been shown to be highly effective in large studies. Some people experience wheat sensitivity which is

much more commonly a non-allergic food reaction than an allergic one. When gluten (the main protein in wheat) causes an allergic food reaction, the diagnosis of celiac disease is made. Blood tests and biopsies of gastrointestinal tissues can help establish the diagnosis of celiac disease, but these tests do not detect non-allergic wheat sensitivities. The diagnosis and management of food sensitivities is complicated. The lack of reliable laboratory markers makes it difficult to identify foods that may be causing problems for that dancer. A trial-and-error approach is often used where potentially problematic foods are removed for a short period and then reintroduced to assess the response.

Alcohol, especially when combined with sugar, increases cellular aging and inflammation in the gastrointestinal tract that can lead to high levels of systemic inflammation. Alcohol also causes disinhibition which we are more likely to overindulge in other foods that contribute to inflammation when under the influence. Alcohol consumed mindfully and in small quantities (generally considered to be one drink three times a week or less) will not likely be a contributor towards systemic inflammation.

Hypermobility disorders like Ehlers-Danlos Syndromes (EDS) can affect the gastrointestinal tract anywhere along the way from the mouth to the anus. Gastrointestinal problems (constipation, acid reflux, abdominal pain and/or irritable bowel syndrome) in EDS are common, potentially disabling, and under-appreciated. Nutritional approaches are particularly important in this group in which there is a high prevalence of food allergies including both gluten sensitivity and celiac disease (an immune reaction to gluten) (5).

Supplements

Eating processed or refined foods that are low in vitamins and minerals increases the risk of deficiencies of micronutrients (e.g., zinc and magnesium) critical to the resolution phase of inflammation (the process by which inflammation returns to baseline low levels). Whenever possible, nutrients should be obtained from the diet, no amount of supplementation makes up for a poor diet. Nutritional supplements should be started or changed only under the supervision of your own personal healthcare provider.

Vitamin D is a fat-soluble hormone our bodies make in response to sunlight. Bone health, immune function, pain, mood, and sleep are just a few things impacted by vitamin D levels. Deficiency of vitamin D is associated with numerous diseases and is quite common especially in those with little sun exposure or in those who have darker skin. Some people are unable to achieve adequate levels of vitamin D without supplementation which should be guided by blood levels whenever possible(6). Having a relatively low intake of omega-3-fatty acids also impairs inflammatory resolution. Omega-3 oils promote anti-inflammatory pathways and have been found to provide benefits in a number of conditions including headache and arthritis. Vitamin B12 is important for bone density and healthy blood cells; its deficiency can contribute to pain, insomnia, and suboptimal brain function. Taking a vitamin B 12 supplement may improve symptoms of pain, fatigue, and poor sleep. Vitamin C is a crucial antioxidant needed for tissue repair and adapting to stress. Our requirements can vary from day to day depending on whether stress, injury, or illness is present.

Magnesium is a mineral involved in hundreds of essential metabolic reactions; it's important for optimal bone density, collagen production, regulating blood sugar, sleep, pain, and proper muscle function. Deficiency of magnesium is quite common, so supplementation in some dancers may be beneficial. Unfortunately, blood levels of magnesium are not very reliable as blood tests can be normal despite a dancer having inadequate stores of magnesium in the bones and muscles. Dosing is usually based on bowel tolerance; excessive magnesium supplementation causes diarrhea which can be resolved by lowering the dose. Turmeric and ginger are related anti-inflammatory tubers. Ginger acts as an anti-inflammatory by disrupting a number of different pathways. The active component of turmeric is curcumin. Curcumin has been studied extensively and appears to have effects against several chronic debilitating diseases outperforming many pharmaceuticals(7). A small amount of black pepper improves the absorption of curcumin as does the presence of oil.

Summary

The time to take action and reduce levels of systemic inflammation is now. No single food needs to be eliminated but whole-food, plant-based diets can have profound anti-inflammatory effects (Table 2). Moderation and portion size are key and eat from farms rather than factories whenever possible. It is normal for motivation to fluctuate over time so make the new habits easy to do so it is easier to make good choices. Even adopting one or two anti-inflammatory strategies is helpful. Making good lifestyle choices can reduce inflammation helping you feel better, dance better, and recover more quickly from illness or injury.

TABLE 2: FOOD CHOICES TO LOWER INFLAMMATION

Green: Eat Liberally	Yellow: Eat In Moderation	Red: Avoid Altogether
Dark leafy greens	Meat	Sugar
Beans and lentils	(use as a condiment, avoid	White flour
Yams and sweet potatoes	charring)	Processed meats
Nuts and seeds	Whole grains	Farmed fish
Seltzer or sparkling water*	Eggs	Predator fish****
Avocado	Dairy	Preservatives
Fatty, cold water fish**	Stevia	Processed foods
Mid chain fish***	Fruits	Dried fruit
Spices and herbs	Coffee	Soda and "sports drinks"
Tea - especially green and black		including diet
Oats and barley		Deep fried foods
Olive oil		Packaged sweets
		Alcohol (except red wine and only in moderation)

*choose ones free of sugar and artificial sweeteners
**especially sardines, anchovies, wild salmon
***e.g., trout, snapper, grouper, sardines, anchovies
****e.g., swordfish, shark, tuna

This article has been adapted from the following two peer-reviewed papers:

Brown M A, Howatson G, Quin E, Redding E, Stevenson E J. (2017). Energy intake and energy expenditure of pre-professional female contemporary dancers. PloS one. 2017;12(2): e0171998.

Civil R, Lamb A, Loosmore D, Ross L, Livingstone K, Strachan F, Dick JR, Stevenson EJ, Brown MA, Witard OC. Assessment of dietary intake, energy status, and factors associated with RED-S in vocational female ballet students. Front Nutr. 2019;5:136.

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ENERGY STATUS OF PRE-PROFESSIONAL CONTEMPORARY AND BALLET DANCERS

MEGHAN BROWN, PHD, SENR

In dance populations, there is often an expectation to maintain an ultra-lean body type given the artistic requirements of dance. Certainly, female contemporary dance students and graduates(1), and both intermediate and advanced contemporary dance students(2) have shown significantly lower percentage body fat than non-dancers. Low levels are often considered to be advantageous for movement efficacy and artistic expression in spite of evidence that extremely low body mass and fat mass are known to negatively influence performance and recovery potential.

In their resolve to achieve an aesthetic form, dancers may consume low energy foods with low nutritional value. Alongside this, dancers' workloads are often very high and comparable to other athletes. For instance, workloads of professional dancers may involve 6-10 h of dance training per day and this may be accompanied by additional fitness training. The workloads of student pre-professional dancers as part of dance school programs may also be high, particularly prior to studio showings and exams. Moreover, the typical training schedule of a dancer offers unpredictable and/or limited opportunities for food and drink consumption, likely exacerbating these issues.

The combination of low energy intake and high energy expenditure (particularly through exercise activity) increases the risk of low energy availability in dancers. Energy availability (EA) is defined as total energy intake minus exercise energy expenditure; this is described as the energy available for all other metabolic processes after consideration of exercise activity. Typical healthy adults are advised to achieve an EA of approximately 45 kcal/kg fat free mass (FFM)per day and dancers (as with other athletes) are recommended to maintain an EA above 30 kcal/kg FFM per day (considered the cut off for low EA) to reduce the risk of disorders associated with energy imbalance. For example, long periods with low EA could lead to insufficient peak bone mass, menstrual dysfunction(3,4), reduced lean body mass and subsequently impaired strength and performance, and increased susceptibility to injury(5). The risk of low EA in student dancers is of particular concern given that this could influence growth and development and potentially limit bone mineral density; which typically peaks by the end of the second or early in the third decade of life. Moreover, the risk is likely to be exacerbated by the increase in the quality and quantity of professional dance schools, a concomitant increase in levels of competition, and the persistent perception that a lean physique and low body weight is a prerequisite for success in the profession.

Brown et al(6) and Civil et al(7) sought to determine the energy intake, energy expenditure, and energy availability of 25 female pre-professional contemporary dancers and 20 female pre-professional ballet dancers respectively. They followed dancers across a typical seven day period during their study (ie. five week days with dance training, and two weekend days with no scheduled dance training). Both studies adopted similar methods to estimate energy intake (through self-reported weighed food diaries combined with 24-hour dietary recall interviews) as well as

energy expenditure (accelerometry, basal metabolic rate, and the thermic effect of food). These studies reported that average energy availability over a typical week was 26 ± 13 kcal/kg FFM per day in female contemporary dancers and 40 ± 11 kcal/kg FFM per day for female ballet dancers. As previously described, energy availability levels below 45 kcal/kg FFM per·day is considered reduced energy availability, and less than 30 kcal/kg FFM per day is considered the threshold for low energy availability. Interestingly, both studies reported differences in dietary and/or exercise behaviors when comparing an average weekday (with scheduled dance training) to an average weekend day (with no scheduled dance training). Of note, there was a significantly greater negative energy balance during the average weekday compared to at the weekend in both contemporary and ballet dancers. Moreover, Civil et al(7) assessed factors related to Relative Energy Deficiency in Sport (RED-S) and low EA, including menstrual function and bone health. These authors observed that 65% of participants were classified at risk of RED-S (according to the Low Energy Availability in Females Questionnaire), however, whilst 40% reported menstrual dysfunction, all participants had adequate bone mineral density measured using dual x-ray absorptiometry.

Collectively, these data suggest that female pre-professional contemporary and ballet dancers are not able to effectively regulate their energy intakes to accommodate their energy expenditure, particularly during periods of training, and that this results in suboptimal EA. Adequate EA is essential for maintaining the demands of training, performance, recovery, and for physiological adaptation. Indeed, it is well-documented that protein synthesis may be inhibited by energy depletion and the relationship between carbohydrate intake and glycogen resynthesis appears dependent on total energy intake. Moreover, substantial restrictions in energy, protein, and micronutrient intakes may also disturb immune function. There is a growing body of evidence demonstrating an unsettling prevalence of poor nutrition in dancers. Accordingly, pre-professional contemporary and ballet dancers would benefit from further research in order to develop current understanding of dance specific nutrition. It would also be valuable to identify whether male dancers are at equal risk of energy imbalance. Certainly, evidence suggests that equal proportions of female and male dancers are susceptible to disordered eating(8), providing justification for such research to be conducted in future.

Importantly, more education regarding

"In their resolve to achieve an aesthetic form, dancers may consume low energy foods with low nutritional value."

appropriate nutritional strategies to support dancers' training demands is warranted. Interestingly, Wyon et al (9) argue that it is difficult to determine whether it is dietary restriction or nutritional knowledge, which overrides nutritional intake in dancers. Indeed, these authors reported that dancers with disordered eating display lower levels of nutritional knowledge. Therefore, it is strongly advised that nutritional education is embedded in dance instruction, particularly in regards to the importance of energy balance in periods of increased training and performance demand given that chronic energy deficiency can result in substantial and long-lasting health implications.

This article has been adapted from the following two peer-reviewed papers:

Brown M A, Howatson G, Quin E, Redding E, Stevenson E J. (2017). Energy intake and energy expenditure of pre-professional female contemporary dancers. PloS one. 2017;12(2): e0171998.

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