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CONTENTS

CPE Article

Microbiota-Conscious Dietary Interventions for Depression and Anxiety

by Yasmine Bouzid

For this feature article plus the following one, the Academy of Nutrition and Dietetics, an accredited Provider with the Commission on Dietetic Registration (CDR), has approved a total of 1.5 continuing professional education units (CPEUs), level 2. To apply for ***free*** *CPE credit, go to* [www.scan-dpg.org/nutrition-info/pulse-newsletters/)](www.scan-dpg.org/nutrition-info/pulse-newsletters/) and click ***Take The Quiz Now.*** *Upon successful completion of the quiz, a Certificate of Completion will appear in your My Profile (under the heading, My History). The certificate may be downloaded or printed for your records.*

Learning Objectives

After you have read this article, you will be able to:

- Summarize the differences in microbiota composition among individuals with anxiety and depression in comparison to healthy individuals.
- Explain briefly what is currently known about possible microbiome-gut-brain axis mechanisms and their potential relationship to anxiety and depression.
- Discuss dietary recommendations and considerations that may help improve mental health conditions for individuals with depression and anxiety.

Evidence is emerging that the relationship between dietary patterns and the risk of developing anxiety and depression is complex. When factoring in the gut microbiota, the trillions of resident microorganisms, the metabolites they produce, and the microbial genome (the microbiome), the picture becomes increasingly convoluted. However, some clarity arises from recent studies that begin to illuminate how these factors are interrelated and the potential to use dietary interventions to prevent or adjunctively treat mental health conditions. A 2020 review by Bear et al[1] discusses the multidirectional relationships among diet, the gut microbiome, and depression and anxiety. Research shows there is a link between diet and depression as the gut microbiota influences neurobiology and behavior through the microbiome-gut-brain axis (MGBA), although directionality and exact mechanisms are currently unclear. Routes of communication between the brain and microbiota include the immune system, vagus nerve, and enteric nervous system.

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Because food choices affect microbiota composition, the gut microbiome should be considered an integral factor in diet-mental health relationships.[1] Commensal microorganisms provide benefits to human hosts, including immune education, fiber digestion, and synthesis of essential micronutrients such as vitamins B_{12} and K. *Bifidobacterium* and *Lactobacillus* genera are considered commensal anaerobes as they ferment oligosaccharides and produce short-chain fatty acids (SCFAs) that are important for maintaining the intestinal epithelial barrier, regulating immune function, and promoting satiety.[2-4] Characterizing dysbiosis is difficult and contextually-dependent as microbiota profiles vary inter-individually. A high *Firmicutes*:*Bacteroidetes* phyla ratio has been associated with disease states such as irritable bowel syndrome (IBS). In inflammatory bowel disease (IBD), the *Ruminococcus* genus in the *Firmicutes* phylum is associated with exacerbating inflammation.[5] As researchers learn more about the functions of the microbiota and the effects of perturbations, the potential arises to incorporate knowledge into dietetics practice.

Dietary Patterns, Depression, and Anxiety

The link between diet and depression has been established mainly through observational studies. The etiology of depression is not fully understood and can be ascribed to many biological and neurological changes, including neuroinflammation, altered vagus nerve tone, and monoamine deficiency.[6-8] Designing randomized controlled trials is especially difficult due to many confounding variables such as drug and alcohol use, socioeconomic status, or medical conditions that affect risk of depression and anxiety.[9] In correlative studies, diet patterns incorporating a variety of fruits, vegetables, nuts, seeds, and pulses, such as the Mediterranean diet, were associated with lower incidence of depression in healthy adults.[10] However, other studies have concluded that there is no association between depression and dietary patterns.[11] This brings forth the possibility that reverse causality, in which depressive symptoms influence food choices, may explain correlations.

This phenomenon was examined in a longitudinal study of Australian adults hypothesizing that past depression would predict a future poor diet. Of 3,668 participants, 343 were experiencing a depressive episode at the time of data collection as classified by the Goldberg Depression scale. More than 40% of participants (1,571) had experienced depression prior to study commencement, and of those, 273 were still in a depressive state at the time they completed the Goldberg scale. Participants completed a validated food frequency questionnaire (FFQ) and their diet quality was rated on degree of "healthy" and "unhealthy" patterns characterized by principal component analysis. Individuals who were previously depressed and sought treatment scored higher on their "healthy" dietary pattern scale, defined by consumption of vegetables, fruit, salad, and grilled fish. Those currently experi-

> "The results also suggest there is a complex bidirectionality between diet and depression."

encing depression had lower scores on this scale. Regardless of whether they had sought treatment, those who reported previous depression scored lower on the "unhealthy" dietary pattern, defined by consumption of red meat, chips, fries, and soft drinks. These results, contradictory to the study hypothesis, suggest that individuals acted to improve their diets in response to past depression, possibly with belief in a relationship between physical and mental health.[12] Although diet quality in this study was based on intake of a narrow range of specific foods, the results also suggest there is a complex bidirectionality between diet and depression. Mice fed a high-fat diet as proxy to Western-style diet patterns displayed increased anxiety behaviors, including reduced interest in new

From The Editor

Stay Ahead of the Curve–Part II

by Mark Kern, PhD, RD, Editor-in-Chief

The Hall of Fame pitcher Satchel Paige, known more for his fastball than the curveball he cultivated later in life after an arm injury, overcame many challenges during his career and is quoted as saying, "You win a few, you lose a few. Some get rained out. But you got to dress for all of them." This quote is particularly poignant given today's uncertainty and probably applies to most of our professional lives right now. Despite our difficulties, one constant for SCAN members is that while our quarterly publication may throw some curves your way, you can rest assured that we've worked hard to provide you with valuable content.

In this issue, we offer two relatively short articles that you can use in combination for free CPE units. The first article by Yazmin Bouzid outlines potential connections among dietary intake, shifts in the gut microbiome, and mental health issues. In the second article, Keenan Greyslak, MS describes the utility of the Japanese macaque as a model to study the cardiovascular implications of maternal obesity for offspring. Our final feature article describes a logic model for sports nutrition programs in a collegiate setting developed by Anthony Paradis, MS, RDN, CSSD.

You'll also find an article on using Academy resources to help enhance your earning potential as well as some highlights from the recent "Nutrition 2020" conference, news from our subunits, abstracts in our "Research Digest," and a listing of upcoming events. Just to close, we at *PULSE* hope that you all find ways to step up to the plate and knock the curveballs of life out of the park. Or at least that you put on your most comfy at-home work duds and continue reading this issue.

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stimuli and exploration of an open field, and biochemically exhibited elevated proinflammatory cytokine levels.[13]

A systematic review of randomized controlled trials targeting dietary pattern intervention for anxiety and depression found high levels of heterogeneity in study designs, with 47% showing significant improvement in treatment groups.[14] Of those effective trials, all employed a dietitian who was more likely to recommend increasing intake of fiber-rich vegetables and fruits instead of decreasing red meat consumption or following a low-cholesterol diet.

Microbiome-Gut-Brain Axis

High comorbidity of anxiety and depression in patients with IBD prompted research into the MGBA. A systematic review found that quality of life scores were significantly lower in IBD cohorts compared with healthy individuals. This is likely due to disruption in social relationships and decreases in self-esteem associated with changes in bowel function, surgical scars, and ostomy. This highlights how the burden of disease impairs day-to-day life and can erode mental health.[15]

In an Italian cohort, anxiety and depression were more common in those with Crohn's disease or ulcerative colitis in comparison to healthy controls.[16]

Microbiota composition has been found to be different between individuals with anxiety and depression versus healthy controls. Namely, taxonomic changes in humans with depression showed a pattern for increased abundance of inflammatory *Proteobacteria* and decreased commensal *Faecalibacterium*, a genus that was negatively correlated with severity of depressive symptoms.[17] Individuals with diagnosed generalized anxiety disorder according to the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* (DSM-IV) criteria had reduced commensal short-chain fatty acid-producing bacteria compared with healthy controls.[18] There are no established microbial profiles attributed to anxiety and depression, likely due to individual variation and a range of methods used to evaluate composition.[1]

"This highlights how the burden of disease impairs day-to-day life and can erode mental health."[15]

In addition, mechanisms by which the microbiota affects mental state are poorly understood. Gut microbes interact with the central nervous system through the intertwined neural, endocrine, and immune signaling pathways.[19] Bacteria produce some of the same metabolites that act as neurotransmitters, including gamma-aminobutyric acid (GABA), acetylcholine, and serotonin.[1] GABA plays a role in modulating anxiety responses within brain circuits of the amygdala.[20] A startup company called Holobiome is working to develop therapeutics by targeting GABA-producing microbes. Another group is investigating serotonin production in depression. There is some evidence that people with depression convert less tryptophan to serotonin than to kynurenine, a compound that can form neurotoxic products.[21]

The gastrointestinal tract is an endocrine organ, and low glucagon-like peptide 1 (GLP-1) hormone produced by enteroendocrine cells has been linked to anxiety. In mice with diabetes given a GLP-1 agonist, anxiety-like behavior resolved. In healthy human volunteers given barley kernel bread along with commercially-available *Bifidobacterium* and *Lactobacillus* probiotic pills administered in 4-day supplementation periods, plasma levels of GLP-1 increased.[22] SCFAs, particularly butyrate, produced by fermentation of fiber by microbes like *Bifidobacterium*, stimulate T-regulatory immune cells that control inflammation in the gut.[23]

While there are not yet direct clinical applications, research on the MGBA is promising for dietary approaches to ameliorate depression and anxiety; however, some unknown tertiary factor such as pain may be responsible for the observed associations.

Dietary Components and MGBA

As previously mentioned, a dietary pattern shown to ameliorate depressive symptoms in correlation studies is the Mediterranean diet. Several studies have examined relationships among microbiota composition profiles, diet quality, and mental health. In a cross-sectional study of 116 participants in Greece, investigators determined adherence to a Mediterranean diet by calculating MedDietScore from a validated semi-quantitative FFQ. They found a higher *Bifidobacteria*:*Escherichia coli* ratio and a greater molar ratio of the SCFA acetate in fecal samples of participants with high MedDietScores compared with those with low MedDietScores when stratified by tertiles. There was also a positive correlation between MedDietScore and total SCFA levels.[24] As Mediterranean diet patterns are characterized by vegetable, fruit, and nonrefined grain intake, the greater SCFA levels are likely due to prebiotic dietary fiber fermented by the microbiota. Higher prebiotic content may explain why this pattern is more strongly associated with less depression than poor dietary patterns. In a large study of middle-aged women, a Mediterranean-style diet was associated with lower prevalence of depression.[25]

Another dietary characteristic more prevalent in Mediterranean diets than in Western-style diet patterns is fish consumption. Associations between dietary patterns incorporating fish and risk of depression have been mixed.[1] One study found that individuals with depression had lower omega-3 fatty acid concentrations in their red blood cells, which may be due to oxidative damage rather than insufficient intake.[26] Accordingly, microbiota-induced inflammation may affect the risk of depression in relation to low fish intake. In mice fed a high omega-6:omega-3 fatty acid ratio similar to a Western-style diet, elevated levels of bacteria-derived lipopolysaccharide endotoxemia markers and increased gut permeability were observed in comparison to transgenic mice that could convert omega-6 to omega-3.[27] One study found that offspring of rats fed an omega-3 deficient diet exhibited more fear-induced freezing and depressive behavior compared with controls. There were differences in fecal microbiota profiles in addition to behavior, as omega-3 deficient offspring had a higher *Firmicutes*:*Bacteroidetes* ratio, which is considered detrimental, whereas the supplemented group had higher numbers of commensal *Bifidobacterium* and *Lactobacillus* as adults.[28] Fiber and fish are components of Mediterranean diets whose action, mediated by the gut microbiota, may potentially be beneficial to those with anxiety and depression.
While the mechanisms by which these components interact with each other are not yet fully understood, emerging evidence on relationships among diet, MGBA, and mental health suggest that medical nutrition therapy can contribute to treating anxiety and depression and promoting wellness. Most evidence comes from animal studies, and further research is needed to fully reveal mechanisms. Depression and anxiety are complex conditions affected by many environmental and biological factors. Likewise, the gut microbiota can be modified by genetics, antibiotics, physical activity, diet, and other factors and the overall understanding of implications on commensal health is in its infancy.[29]

Findings thus far suggest that however complicated, mental wellness is influenced by the diet and microbiota. Dietitians may help to improve mental health conditions for individuals with anxiety and depression by recommending dietary patterns that support commensal microorganisms with the evidence currently available. Considerations must also be made regarding food-drug interactions and the potential influence of medications on the gut microbiota for patients with anxiety and depression. The Behavioral Health Nutrition Dietetic Practice Group (BHN DPG) of the Academy of Nutrition and Dietetics revised "Standards of Practice (SOP) and Standards of Professional Performance (SOPP) in Mental Health and Addictions" in 2018, recognizing the MGBA as a critical component of nutrition support for the future.[30] With an expanding pool of scientific evidence, the efficacy of dietitians in helping improve patient and client mental health through dietary approaches will only increase in the near future.

Yasmine Bouzid is a doctoral student in the Graduate Group of Nutritional Biology at the University of California, Davis. Her research interests include how diet and host-microbe interactions affect gut health.

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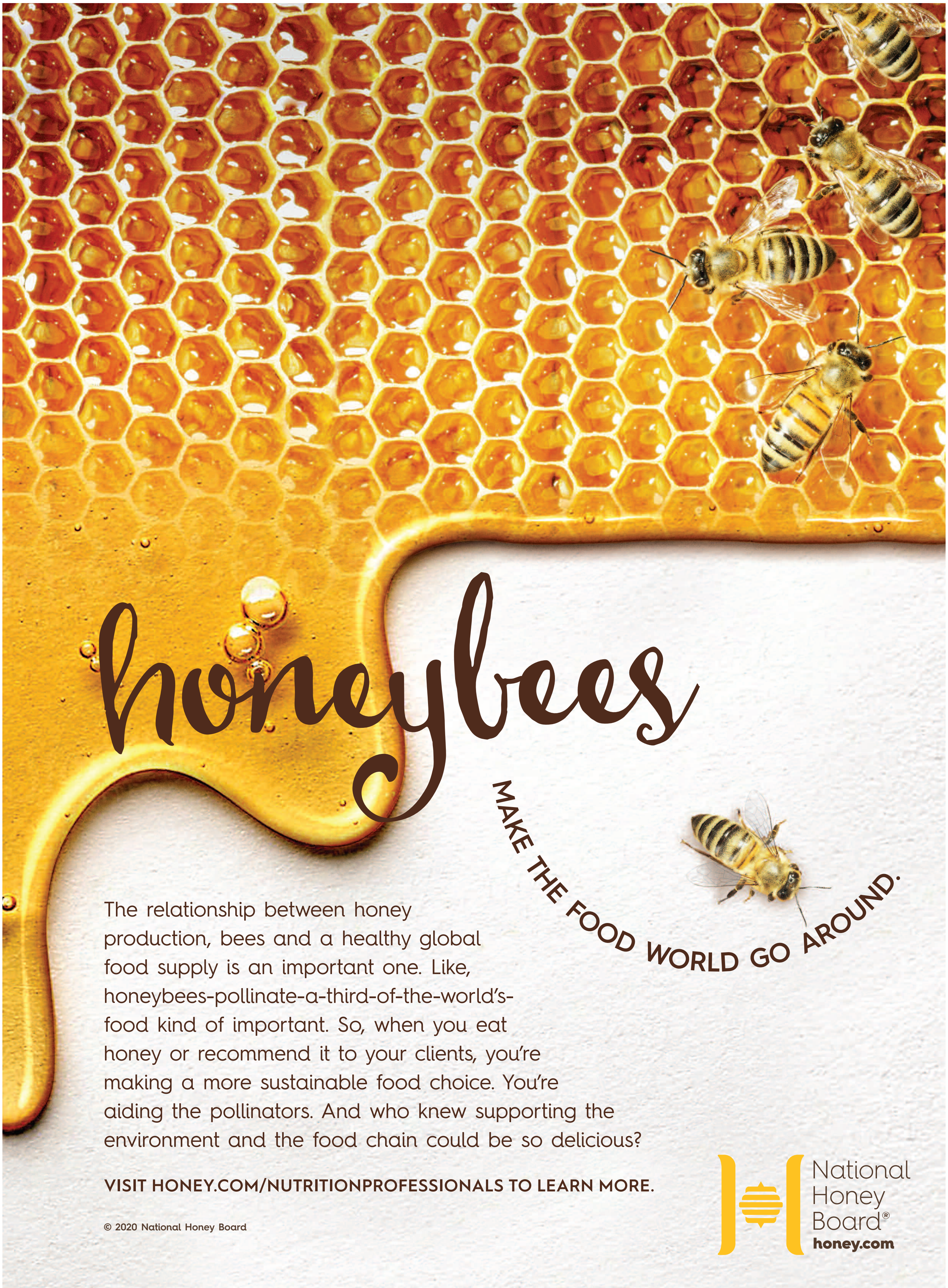

Taken to Heart: Lessons from the Japanese Macaque Model of Obesogenic Pregnancy

by Keenan T. Greyslak, MS

*For this feature article plus the preceding one, the Academy of Nutrition and Dietetics, an accredited Provider with the Commission on Dietetic Registration (CDR), has approved a total of 1.5 continuing professional education units (CPEUs), level 2. To apply for **free** CPE credit, go to [www.scan-dpg.org/nutrition-info/pulse-newsletters/)](www.scan-dpg.org/nutrition-info/pulse-newsletters/) and click **Take The Quiz Now.** Upon successful completion of the quiz, a Certificate of Completion will appear in your My Profile (under the heading, My History). The certificate may be downloaded or printed for your records.*

Learning Objectives

After you have read this article, you will be able to:

- Explain the role of skeletal muscle in regulating whole-body metabolism and identify the cardiometabolic abnormalities correlated with dysfunctional skeletal muscle.
- Summarize the various impacts of maternal nutrition on the metabolic health of offspring, as elucidated by the Japanese macaque model.
- Discuss the effects of reversing maternal diet on fetal skeletal muscle and the effects of reversing offspring to a healthy postweaning diet on metabolic discrepancies in adolescent skeletal muscle.

Cardiovascular disease (CVD) is the leading cause of adult mortality in the United States,[1] with a predicted annual cost of $1.1 trillion by 2035.[2] The risk of developing CVD is twice as high for individuals diagnosed with the cardiometabolic syndrome,[3] a cluster of metabolic complications—including obesity, hypertension, hyperglycemia, dyslipidemia, and insulin resistance—that are commonly featured in comorbidities such as type 2 diabetes (T2D) and nonalcoholic fatty liver disease (NAFLD). Importantly, it is the loss of insulin sensitivity (i.e., insulin resistance) that defines the cardiometabolic syndrome, making it a strong predictor of adult CVD.[4-6]

Skeletal Muscle Insulin Resistance

Insulin signaling modulates whole-body energetics by regulating the intermediate metabolism of adipose tissue, skeletal muscle, and the liver. As a key target tissue and highly metabolic organ, skeletal muscle mediates systemic glucose homeostasis by accounting for 80% of insulin-stimulated glucose disposal.[7] In addition to glycolysis and glucose oxidation, the energetic demands of skeletal muscle are also met via lipid uptake and utilization, further emphasizing its role in regulating whole-body metabolism.

> "…an improved understanding of how maternal adiposity and nutrient stress relate to fetal metabolic reprogramming is pivotal to address this obesogenic crisis."

The bioenergetic hubs of glucose and lipid oxidation are found in the mitochondrial networks populating skeletal muscle. The efficiency of these networks is determined by the organelle's capacity to integrate stress signals with nutrient stimuli and substrate availability. This ability to adapt to such dynamic environmental cues is contingent upon mitochondrial substrate flexibility,[8,9] oxidative capacity,[10,11] cristae architecture,[12] morphology,[13-15] and network integrity.[16-18] With critical roles in both local and global nutrient use and regulation, it is no surprise that loss of mitochondrial health associates with the development of cardiometabolic syndrome phenotypes.[19,20] Specifically, dysfunctional skeletal muscle mitochondria correlate with suppressed insulin action,[21-23] hyperglycemia,[24] and elevations in inflammatory lipid species[25] and oxidative stress.[26,27]

DOHaD: Breaking the Cycle

Conceived by David Barker, MD, the Developmental Origins of Health and Disease (DOHaD) Hypothesis, or "fetal programming," has introduced a new dimension in understanding the timing and underlying mechanisms of human health/disease as it relates to early life environment, (epi)genetics, and lifestyle choices. Within the global context of DOHaD is the study of how exposure to features of Western society, namely maternal obesity and chronic high-fat/high-sugar and low-fiber diets (deemed Western-style diets [WSDs]), may redirect the gestational and future trajectory of health outcomes in children.

Studies in both clinical cohorts and controlled animal studies have generated a convincing body of evidence to support the premise that maternal obesity, poor maternal nutrition, or family history of insulin resistance result in fetal adaptations that increase risk of cardiometabolic complications in adult life of both the offspring and their subsequent progeny (up to two generations).[22,28-31] It is this intergenerational inheritability of metabolic disease extending beyond individual lifestyle choices that perpetuates the vicious cycle of modern-day obesity and metabolic disease development. With two-thirds of U.S. women entering pregnancy as either overweight or obese,[32] an improved understanding of how maternal adiposity and nutrient stress relate to fetal metabolic reprogramming is pivotal to address this obesogenic crisis. However, the methodology required to gain this insight during human gestation, infancy, and early childhood present significant barriers when attempting to distinguish the primary drivers of transgenerational metabolic disease.

The Japanese Macaque

The use of rodents, ruminant mammals, and drosophila as model organisms of fetal programing have provided strong evidence that offspring exposed to an obesogenic environment in early life experience deviations in the development of important metabolic systems, placing them at a higher risk of developing cardiometabolic diseases in adulthood. However, discrepancies in ontogeny, placental function, nutrient handling, and substrate metabolism introduce limitations when extrapolating these findings to a clinical setting.

By prioritizing control of nutritional environment, consistency in nutrient regulation, gestational timing of development, and intrauterine environment relative to human primates, the Japanese macaque has been developed over the past two decades to advance our understanding of early life exposure to WSDs and obesity (e.g., body fat >30%). Fortuitously, in addition to dams who developed obesity on the WSD, a subset of females remained lean following chronic consumption of the same low-fiber diet high in saturated/omega-6 fatty acids, sucrose, and fructose—thereby allowing for the investigation of poor maternal nutrition alone or in combination with obesity on offspring metabolic health.[33] To date, this nonhuman primate (NHP) model has taught us that offspring chronically exposed to maternal (m)WSD in utero and through lactation display alterations in thyroid axis homeostasis;[34] behavior and neural development;[35-37] liver metabolism;[33,38,39] response to nutrient challenge;[40] endothelial function;[41] and skeletal muscle insulin action, glucose uptake, and mitochondrial function[42,43] in a manner that suggests a predisposition for the cardiometabolic syndrome and development of CVD, NAFLD, and/or T2D.

Efficacy of Dietary Interventions

As a practical and readily translatable strategy, dietary interventions were investigated as a means of attenuating fetal metabolic modifications following obesogenic environment exposure. To accomplish this, two separate approaches were implemented. First, dams with WSD-induced obesity were switched to a healthy control diet just prior to conception to see whether the absence of an obesogenic diet during pregnancy was adequate to avoid metabolic reprogramming of fetal tissues. Although this approach improved the phenotype of certain fetal organs like the liver,[38] this diet intervention in obese mothers was unable to circumvent loss of mitochondrial function or glucose oxidation previously observed in maternal obesity- and mWSD-exposed fetal muscle.[43] The ability of maternal diet reversal to rescue offspring skeletal muscle function postnatally is still under investigation.

> "The ability of maternal diet reversal to rescue offspring skeletal muscle function postnatally is still under investigation."

The second intervention tested the efficacy of offspring diet reversal in addressing the long-term impact of early life mWSD exposure. Adolescent NHP offspring exposed to mWSD demonstrated reduced glucose area under the curve (AUC) relative to controls during an oral glucose tolerance test (oGTT).[44] This observation was seen in parallel with elevated insulin AUC, indicating inappropriate insulin response to maintain glucose homeostasis.[44,45] In skeletal muscle, preliminary data suggest that substrate flexibility (i.e., glucose oxidation in the presence of lipid), oxidative capacity, and markers of mitochondrial health—including network dynamics, architectural integrity, and quality control—were diminished in mWSD-exposed offspring.[44] Interestingly, these findings were seen in the absence of both maternal and offspring obesity. Importantly, switching these exposed adolescent offspring to a healthy postweaning diet for several years was unable to successfully rescue these metabolic and mitochondrial abnormalities in skeletal muscle.

In Summary

This Japanese macaque model of obesogenic pregnancy continues to remind us that prevention is key. With due consideration and sensitivity toward the challenges that surround human diet styles, weight management, and pregnancy, this NHP model is able to avoid the confounding variables introduced by human autonomy while still possessing the physio-anatomical similarities that make these studies relevant and translatable to human medicine. In this way, the Japanese macaque has amplified our understanding of the developing primate's propensity for metabolic disease in a Westernized, obesogenic setting in multiple ways.

First, we can see how impactful past and present maternal nutrition can be on the future metabolic health of the offspring. The placenta, linking the womb to the outside world, creates an intrauterine environment that is reflective of maternal condition, priming the developing fetus for postnatal life. In addition to the intrauterine environment's direct and immediate impact on fetal metabolism, data in this NHP model suggest that chronic nutrient stress within the womb may alternatively cause functional or structural adaptations that do not result in overt metabolic dysfunction but rather reduce offspring capacity to respond to future environmental insults. In this way, the lack of outward phenotypes and subsequent lapse in timely diagnosis or therapeutic intervention would make the cardiometabolic syndrome, an already silent killer, even more deadly.

Next, the Japanese macaque has demonstrated that morphological and functional modifications to fetal tissue are not isolated to any one organ or physiological system but appear to manifest globally. This results from the presence of metabolic perturbations during distinct critical windows of development, or instances when clusters of cells, tissues, or developing organs have a heightened sensitivity to environmental stimuli. This model would suggest that excess lipid exposure, whether endogenous or exogenous in origin, during these timepoints in development is enough to impact skeletal muscle's function and whole-body glucose homeostasis at an early age that extends beyond the neonatal period, providing further evidence for increased risk of future metabolic diseases in exposed offspring.

Lastly, while diet interventions may be adequate to counteract alterations in other offspring tissues, it may not be an effective agency for reversing phenotypes seen in skeletal muscle. Changes in fetal muscle metabolism could not be attenuated by switching obese mothers to a high-fiber, nutrient dense diet immediately before pregnancy. In addition, placing mWSD-exposed offspring on a healthy postweaning diet throughout childhood was also unable to offset programmed modifications within adolescent muscle. The capacity for diet reversal in obese mothers to prevent these seemingly permanent metabolic modifications in exposed skeletal muscle after birth, however, is still under investigation (**Fig. 1**). Interventions aside, the presence of functional discrepancies in exposed offspring even in the absence of overt signs of metabolic dysfunction, obesity, or postweaning WSD consumption is concerning at best. These data from the Japanese macaque add to the body of evidence that asserts early life exposure to poor maternal nutrition and obesity is a clinically relevant component of an individual's health profile. Furthermore, this information may better assist health care professionals in effectively monitoring, diagnosing, and treating patients with heightened risk of developing the metabolic syndrome/CVD who would otherwise go unnoticed due to lack of any obvious signs, symptoms, or risky lifestyle behaviors. To protect the heart, these additional considerations must be taken to heart.

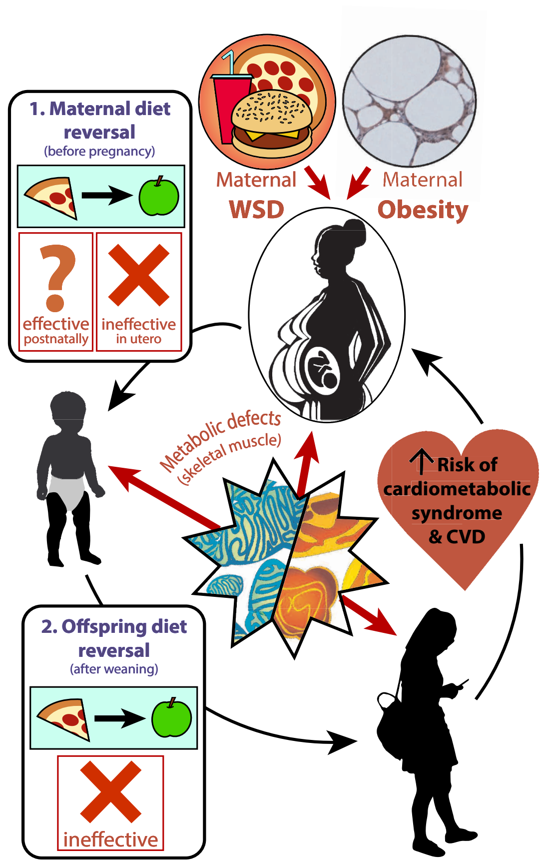

Figure 1. Maternal Diet Programs Offspring Metabolism. Poor maternal nutrition (Western-style diet, WSD) and/or obesity during gestation and lactation alters offspring metabolism (assessed in utero, infancy, and adolescence) in a manner that suggests an elevated risk for CVD. Maternal diet reversal could not negate altered phenotypes in fetal skeletal muscle. Reversing offspring to a healthy postweaning diet could not effectively address metabolic discrepancies in adolescent skeletal muscle. Evidence is still forthcoming as to the long-term effectiveness of maternal diet reversal.

Keenan T. Greyslak, MS, is a doctoral candidate in the Molecular Metabolism and Endocrinology Lab at the University of Oregon. He studies the impact of maternal diet and obesity on mitochondrial structure and function in the skeletal muscle of adolescent Japanese macaque offspring.

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Presentation of a Logic Model for Collegiate Sports Nutrition Programs

by Anthony Paradis, MS, RDN, CSSD, CSCS, USAPL

Nutrition serves as a key component in the effort to optimize an athlete's performance and recovery in a collegiate setting.[1] Because of their rigorous training, student athletes have higher energy and nutrient needs and may benefit from dietary supplementation coupled with individualized nutrition counseling from a sports dietitian.[2] After the National Collegiate Athletic Association (NCAA) deregulation of the feeding of student athletes in 2014, the field of collegiate sports dietetics expanded rapidly. A survey of 31 NCAA Division-1 programs found that following this deregulation, food budgets increased by an average of 145%.[3] In 2019, 92 NCAA Division-1 universities employed full-time sports dietitians to head their sports nutrition programs, a huge increase from just 13 universities in 2007.[4]

The Sports, Cardiovascular, and Wellness Nutrition (SCAN)[5] Sports Performance subgroup aims to promote the services of sports registered dietitians (RDs). The documentation and reporting of athletes' needs, nutrition services, and the impact of such service may aid in promoting sports dietitians in a collegiate setting. Karpinski et al [6] have noted that as sports dietetics continues to grow, "it is becoming more important to collect data that support the cost-effectiveness of sports nutrition services for athletes." Parks et al,[7] in discussing sports nutrition education programs, wrote that "Sports nutrition programs at some large universities may have 6-figure budgets but no documentation of the education program."

In light of this lack of documentation, this article outlines the framework for a Collegiate Sports Nutrition (CSN) Logic Model to be utilized by sports RDs in the development and reporting of their sports nutrition programs. A logic model[8] provides a comprehensive framework to plan, operate, and evaluate all components of a program and may be useful to collegiate sports dietitians in developing programs and reporting their impact to key stakeholders, such as directors of athletic programs. Logic models serve as a tool for program design and planning, program implementation, and program evaluation and strategic reporting. Other logic models, such as the Community Nutrition Education (CNE) Logic Model, have been employed in the field of community nutrition for program planning and evaluation.[9]

This article discusses each component of the Collegiate Sports Nutrition (CSN) Logic Model, including the situations and priorities of an athletics program, and related inputs, outputs, outcomes, assumptions, and external factors. Formative and summative evaluations are performed to review the program throughout the year.

Situation and Priorities

Situations and priorities affecting the needs of the student athletes, teams, and athletic programs differ for each university. Caffarella and Daffron[10] recommend that program planners gain support from stakeholders as a step toward the development of a program. Different perspectives should be sought through discussion with student athletes, athletic directors, coaches, staff, faculty, and other key stakeholders to ensure their investment in the program.

Needs Assessment

A dietitian's needs assessment should collect and interpret data on three levels: 1) the athletic program, 2) the team, and 3) the individual athlete. Both formal and informal approaches to needs assessment should be employed.

One example of a formal needs assessment is a survey. Many validated surveys exist for use by sports dietitians to assess athletes at the individual level. Examples include assessments for evaluating sports nutrition knowledge, food insecurity, eating disorders in female athletes, and athlete sleep habits.[11-14] Alternatively, an informal needs assessment includes conversations with coaches and trainers about what the student athletes eat when traveling or by observation of student athletes' food choices at a dining hall or fueling station. Assessments should inform decisions about goals and objectives that lead to outcomes regarding the athletic program, the team, and the individual athlete.

Goals and Objectives

Program goals and objectives can be determined after completion of a needs assessment. In general, the goal of a sports nutrition program is to provide education and resources that increase the likelihood of student athletes making food choices consistent with current standards of sports nutrition science and practices while maintaining compliance with NCAA regulations. The specifics of the program's objectives should be individualized to the program's needs, situation, priorities, and context.

Sample outcomes addressing the individual athlete include: 1) improvements in diet quality, nutrition knowledge, or changes in behavior (commonly assessed through food recalls, food journals, questionnaires, interviews, observations); 2) identification of nutrition support and resources (commonly assessed through questionnaires or interviews pertaining to student athletes' knowledge and use of support and resources such as fueling stations, campus food pantry, and dining halls); 3) identification and use of credible sources of nutrition information; and 4) gains in knowledge or changes in behavior pertaining to shopping and food resource management (e.g., Can student athletes demonstrate ability to plan a menu, shopping list, and budget? Knowledge about food storage and food safety also applies here).

Inputs

Inputs (resources required) for a collegiate sports nutrition program include financial resources, equipment and materials, building space, collaboration efforts, and human resources.

Financial Resources

Athletic directors will want to know the rationale and budget for each output (service) provided in a sports nutrition program. In established programs, there may already be a set budget for sports nutrition. In the case of a newly created program, money will often be requested by the sports dietitian for each project. As a sports nutrition program becomes more established, there may be opportunities for outside financial resources to strengthen the nutrition program with grants and corporate sponsorship.

Equipment and Materials

The equipment and materials category includes tools needed to administer nutrition services. When assessing equipment and materials needs, consider the following: 1) medical assessment instruments; for example, digital scales, measuring tape, body calipers, bioelectric impedance devices, dual-energy x-ray absorptiometry (DXA) scanners, and other devices may be needed for your program; 2) software for nutrition analysis, charting, scheduling, surveys, newsletter, team communication, video/audio recordings, and printing materials; 3) food and dietary supplements; and 4) food processing and storage equipment. These items, used for fueling stations and training table programs, should be discussed in collaboration with the foodservice contractor, university, sports dietitian, and athletics administration.

Building Space

Ideally, a sports nutrition program will designate building space for the dietitian's office and fueling stations. Proximity to the student athletes may promote communication between the dietitian and athlete. Building space could also be flexible through the use of mobile equipment. For example, a sports nutrition program could use a food truck as fueling station for athletes across campus.

Collaboration Efforts

Collaborating with other departments can add resources for a sports nutrition program that might not otherwise be attainable. Many departments across campus can serve as collaboration partners in the sports nutrition program. These might include: 1) the nutrition department (for providing student volunteers; 2) the exercise science department (for sharing assessment equipment; 3) the education department and psychology department (for aiding in the development of survey instruments; 4) dining services (for providing athlete fueling); and 5) strength coaches and sports medicine (for promoting or reinforcing nutrition education).[15] A collaboration with a Department of Agriculture could also facilitate a "farm-to-fueling station" initiative, which may provide additional sports nutrition internship opportunities.

Human Resources

Personnel are needed for execution and growth of a successful sports nutrition program. A program often starts with a single full- or part-time dietitian. Initially, a cost-effective personnel strategy may include nutrition and exercise science undergraduate volunteers. A variety of degree programs require student volunteer hours that can be utilized for tasks such as serving as a fueling station aid or for imputing data. Involving dietetic interns who are seeking to complete their accredited internship program and/or professional licensed dietitians who are seeking to gain sports nutrition experience enables them to gain additional experience to include on their resumes. These individuals may assist with higher-level tasks, such as assisting during team assessments or nutrition analysis of menus, and they may be available for more hours per week or may be able to provide a longer commitment. Sports RDs can register to serve as an internship preceptor on the website of the Academy of Nutrition and Dietetics.

As a long-term plan, human resource personnel may include additional full- or part-time sports dietitians, hired assistants, and paid graduate assistantship positions. Working with student volunteers and interns will aid in establishing a stronger idea of what is needed in these long-term positions.

Outputs

Outputs include services offered at the individual athlete, team, and athletic program levels. At the individual athlete level, the student is working with the sports dietitian to develop an individualized plan. Example outputs might be counseling sessions, foods offered at fueling stations, or group nutrition education sessions.

At the team level, the dietitian is working with the team coaching staff and student athletes. Passive outputs at the team level include such activities as nutrition posters, shopping list handouts, and newsletters. Active outputs are often described as "team talks," workshops, or hands-on lessons. In some form or another, these are an interactive education process with the dietitian. Common activities include group meal planning, grocery store tours, presentations on specific topics, and cooking demonstrations. The dietitian can also provide consulting to the coaching staff on team nutrition policies for hydration, training tables, refueling on the road, and other nutrition opportunities.

At the athletic program level, the dietitian is interacting with the athletic administration or the entire athletic program. Passive outputs include distribution of information in email or newsletters. An example of a nutrition policy at the program level is to screen and refer for eating disorders for all athletes upon admission. Active outputs also include workshops and educational interactions with the dietitian. One example of a program-wide output could be an online nutrition class that all freshman student athletes are required to take. Fueling stations and training tables can also be implemented at the program level for all teams.

Outcomes

In the logic model, outcomes such as results, or impacts, are broken up into three levels (individual, team, and athletic program) and three sub-levels (short-term, mid-term, and long-term outcomes).

At the individual level, short-term outcomes are described as changes in knowledge. The four areas the author has included for changes in knowledge are diet quality; identification of nutrition support and resources (such as use of a meal plan or fueling stations); identification of credible nutrition resources (and familiarity with NCAA supplement regulations); and knowledge of shopping and food resource management. Assessments such as a pre-test/post-test, a retrospective pre-test, or personal interviews may be considered to evaluate changes. Mid-term outcomes can be measured by observation, interview, and survey to confirm that changes of behaviors and incorporation of skills have taken place. Long-term outcomes are physical changes in the student-athlete that change performance indicators, such as an increase of muscle mass, and risk factors such as low serum iron levels. Changes in long-term outcomes are likely to have the most meaning for coaches and student-athletes.

At the team level, a short-term outcome includes raising awareness of opportunities among coaches with the aim of developing a team culture that embraces sports nutrition. An example would be increased awareness among coaches and athletes regarding post-exercise refueling strategies. A mid-term outcome would be a team's commitment to change through development of a refueling station. A long-term outcome would be the permanent implementation of that fueling station for the team.

At the athletic program level, a short-term outcome is raising awareness of nutrition problems and possibilities. If the administration in the athletic department is on board with the goals of the nutrition program, a mid-term outcome would include the level of commitment to change made by the administration on behalf of the athletic program. A long-term outcome at this level may include development of a new or revised nutrition policy that improves student athlete fueling.

Evaluation

Evaluation is an ongoing process throughout each step of this model. Formative evaluation focuses on evaluating the level of improvement among the internal activities of the model, which may include implementing a quiz at the end of a team talk or a satisfaction survey for the fueling station. Summative evaluations focus on the overall outcomes and the results of your program such as measuring the impact of nutrition education efforts through a written exam, or measuring the perceived impact of your program through structured interviews for athletes and coaches at the end of each year. Understanding processes and results is key to recalculating the plan for reassessment and improvement.

The next step involves reporting on these evaluations to audiences in a meaningful way. Creating a one-page impact report with highlighted features and components of the program can be an effective way of reporting to key stakeholders. Finally, sports dietitians should consider sharing the program results at the professional level either informally through message boards and conversation or formally through a conference presentation or publication. Such data and input will aid in supporting the efficacy of sports dietitians in the field and add to the literature on collegiate sports nutrition.

Implications for Practice

The CSN Logic Model proposes a sequence of steps and phases that a collegiate sports dietitian can use to plan and evaluate a sports nutrition program. As the field of sports nutrition continues to grow, this logic model may provide a conduit for practitioners to plan, implement, and evaluate outcomes in their sports nutrition programs. The author's personal communications with another sports RD colleague indicated the CSN Logic Model was useful in developing a new sports nutrition program proposal (Meghan L. Scott, MD, RD, email communication, December 17, 2019). Ultimately, the communication of reported program outcomes will be an important step for continued strengthening and legitimizing the development of sports dietitian-led nutrition programs.

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From **The Chair**

Change Is Hard, Exciting, Inevitable … *Happening* with SCAN

by Christine Karpinski, PhD, RD, CSSD

The current pandemic and other recent events have brought significant changes to people across the globe. For SCAN members, those changes are happening on many fronts:

Change in the way we do things. COVID-19 has completely changed the way we care for our athletes, clients, and patients. We now do much of our counseling virtually, and when we counsel in-person, we talk through a mask. Many of our food-service delivery systems have had to be revamped. SCAN is demonstrating how flexible and relevant we can be as leaders through the webinars and fact sheets we've been offering and will continue to offer this year.

Change in the way we look at the world. Our statement posted online in June deserves repeating: "#SCANstrong is our hashtag, and we stand strong in opposition to the systemic racism and hatred that contributed to the heartbreaking events of this past summer, particularly the killing of George Floyd. Black lives matter; they have always mattered. We unequivocally denounce and condemn police brutality and recognize the necessity of naming the systematic and deliberate ways that racism shows up in our communities and profession."

In this vein, we welcome Manju Karkare, SCAN's first-ever diversity liaison to the Academy. Manju served as an Academy diversity leader, one of four chosen nationwide by the Academy from 2012-2014, and is a past treasurer of the Academy. We also welcome Lilian Nwora Shepherd, an up-and-coming corporate wellness and private practice RD who will act as SCAN's diversity associate under the direction of Manju. The SCAN Executive Committee is working with Manju and Lilian to develop programming and initiatives around diversity and inclusion. Concurrently, our Sports Performance subunit is working with Gatorade to develop a diversity program under project manager Briana Butler.

Change in policy. The PAL SCAN Cardiovascular Health Subunit Regulatory Comments Expert Response Team, led by Geeta Sikand, subunit director, addresses policy changes. Team members include Linda VanHorn, Penny Kris-Etherton, Kim Larson, Karen Collins, and Sharon Smallings. As an example, the team recently was asked to submit comments to the United States Preventive Services Task Force (USPSTF) regarding its 2018 Draft Research Plan for High Blood Pressure in Adults: Screening.

Change in the way we get paid. SCAN is very interested in the progression of the 2020 Medical Nutrition Therapy Act. The CV Health subunit is working with influential health care organizations such as the National Lipid Association and American Society of Preventive Cardiology to support this bill. As of this writing, 35 health care organizations are supporting this bill. The Medical Nutrition Therapy Act of 2020 allows Medicare beneficiaries to access the care they need through Medicare Part B coverage for MNT for prediabetes, obesity, hypertension, dyslipidemia, malnutrition, eating disorders, cancer, celiac disease, HIV/AIDS, and any other disease/condition causing unintentional weight loss and other disease/condition as determined medically necessary. This legislation also authorizes nurse practitioners, physician assistants, clinical nurse specialists, and psychologists to refer patients for MNT (Source: www.eatrightpro.org/advocacy/legislation/all-legislation/medical-nutrition-therapy-act)

Change in the way we offer member benefits. We hope you've noticed the significant increase in SCAN's webinars and Webbies since April. We also hope you noticed they were *free*, as part of your member benefits. We are busy making plans for the virtual 2020 Food & Nutrition Conference & Expo (FNCE) and the pre-FNCE workshop. FNCE always provides plenty of sessions on SCAN's three areas of focus. This year's SCAN Spotlight Session is "Soft Tissue Health: Nutritional Strategies for Injury Prevention and Recovery," with presenters Drs. Keith Baar and Dana Lis. Look for it! We hope we can all be together at Symposium '21 in Boston on March 4-8. But if we can't, we'll pivot and go virtual.

Change in administrative leadership. Please welcome Rebecca Frabizio, a senior member of the Academy who will serve in the role of SCAN executive director. Rebecca has 13 years of professional experience, including managing, directing, and assisting entrepreneurs and small business owners at nonprofit organizations, start-ups, and creative arts offices in Los Angeles and Chicago. She brings expertise in planning and managing events, business development, administration, and working with volunteer member leaders.

While all these changes are happening—**some things haven't changed!** As a SCAN member, you have all the great member benefits you've always had, including *PULSE, The Beat,* SCAN fact sheets, access to the *Natural Medicines Database*, and—new since January—access to the full-text EBSCO database.

Conference Highlights

"Nutrition 2020 LIVE Online"
American Society for Nutrition

https://meeting.nutrition.org

Given the COVID shutdown, the American Society for Nutrition (ASN) had no choice but to cancel *Nutrition 2020*, their annual conference that had been scheduled for May 30 to June 2 in Seattle. In March, ASN chose to quickly reformat the conference as *Nutrition 2020 LIVE Online*. It included more than 20 hours of programming spread over 4 days. The entire ASN organization worked quickly and efficiently to make this happen. Kudos to them!

The ASN Foundation sponsored the event. This allowed ASN to offer the virtual meeting at no charge. Because the virtual meeting was open to anyone interested in participating, *Nutrition 2020 LIVE Online* became the world's largest nutrition meeting, with 25,649 registered attendees from 150 countries. Among this record-breaking attendance were scientific researchers, practitioners, dietitians, physicians, nurses, global and public health professionals, policy makers and advocacy leaders, academicians, students, postdoc researchers, industry leaders, and journalists.

The online program included live debates, panel discussions, lectures with live question/answer periods with the speakers, 1,800 abstracts (with the option to present the information as an e-poster with a 10-minute recorded audio presentation), a virtual expo hall, and more. This was quite a successful undertaking, given the short amount of turnaround time to pull it all together.

The following highlights from original research studies presented in the e-poster sessions can help SCAN members stay on top of the latest nutrition news. The number and name in parentheses indicate the abstract number and author's last name.

■ Does eating low glycemic foods as part of a Mediterranean-style healthy eating pattern (MHEP) offer more protection against type-2 diabetes and cardiovascular disease compared with a higher glycemic MHEP? Investigators explored that question in a randomized controlled study involving 33 women and 21 men (mean age 49 y; mean body mass index [BMI] 31). Participants ate an isocalorie MHEP diet for 12 weeks in which 135 g of carbohydrate were obtained from foods with either a low or a high glycemic value. Although all indices of metabolic health improved, the researchers reported no significant differences in magnitude of improvement between the high and low glycemic groups. Given these findings, is the glycemic index over-valued? (P07-009-20 Bergia)

■ A high-quality diet compared with a lower-quality diet is associated with more diversity in gut microbes, including more microbes from four families and 15 genera of microbes. Several of those types of microbes have been linked to lower risk of metabolic and inflammatory diseases. The results of a study with 1,130 participants from the Netherlands showed that no one specific food group can explain the positive impact on the microbiome. This finding underscores the importance of RDs encouraging athletes to eat a variety of nutrient-dense foods for optimal health. (P07-014-20 Voortman)

■ Savory snacks, including chips, popcorn, pretzels, and flavored snacks, are popular among Americans. The savory snack market is worth more than $35 billion. These foods are readily available, inexpensive, and popular to eat. On any given day, more than one in three Americans consumes about 1.5 oz of a savory snack, and hungry athletes have been known to eat a lot more than that! It's unfortunate that fruits and vegetables aren't as popular as savory snacks! (P07-030-20 Hymes)

■ While dual energy X-ray absorptiometry (DXA) measures lean body mass (LBM), it does not delineate muscle from visceral organs and body water. A better way to measure muscle mass can be with the creatine (methyl-d3) dilution method, a novel way to measure total body skeletal muscle mass. By orally dosing individuals with deuterated creatine (d3-creatine) and then subsequently measuring labeled creatinine (d3-creatinine) in a single urine sample, researchers can estimate the total creatine pool size, and thus estimate total body skeletal muscle mass. (P10-007-20 Berryman)

■ Interesterified fat (IEF) is a type of fat in which fatty acids have been moved from one triglyceride molecule to another to modify the melting point and slow rancidification. IEFs are now used as hard fats to replace harmful trans fats. However, it's unknown whether these IEFs have a positive or negative impact on cardiometabolic health. A randomized controlled trial found no acute (4-8 hr) adverse effects on cardiometabolic risk factors among 50 healthy males and females (ages 35-75 y). They consumed high-fat test meals with a commercially available IEF spread, a non-IEF spread, spreadable butter, or rapeseed oil (representing a high monounsaturated fatty acid control fat). More research is needed to determine the long-term effects of IEFs. (P10-023020 Gibson)

■ Observational studies indicate that people who eat whole grains tend to have a lower BMI and are less likely to gain undesired weight. Why is that? A review of the literature confirms that the intake of whole grain foods (compared with intake of refined grains) reduces perceived hunger, so people consume fewer calories. (P10-050-20 Maki)

■ Protein that is quickly digested and absorbed as amino acids leads to a quick increase of circulating amino acids in the blood. Does this have a positive impact on muscle protein synthesis? This question was addressed in a study in which 24 healthy subjects (mean age 22 y; mean BMI 23; 12 males, 12 females) ingested either labeled protein from milk or the equivalent amount of free amino acids. The researchers followed the muscle protein synthesis rates for 6 hours. The results indicated that ingesting free amino acids (as opposed to intact milk protein) contributes to a more rapid rise in amino acid absorption, but this does not boost muscle protein synthesis rates. Once again, a supplement does not outperform a whole food! (P10-066-20 Weijzen)

■ Some athletes believe consuming artificially sweetened beverages is bad for one's health, but is higher mortality associated with artificially sweetened beverages (ASB) more so than with sugar-sweetened beverages (SSB)? Based on data from the 1999-2014 US National Health and Nutrition Examination Survey (NHANES), people who consumed the sugar-sweetened beverages had a higher risk of mortality from all causes, from heart disease, and from other causes. No association was found with the artificially sweetened beverages and mortality risk. Neither SSB nor ASB were associated with cancer mortality. (P10-069-20 Zhang)

■ Would college athletes be interested in having a nutrition app, and if so, what nutrition information would they want? Based on conversations in focus groups with athletes from several sports (volleyball, softball, football, and men's and women's soccer and track), researchers sent out a survey to 130 student athletes. The athletes expressed interest in having a nutrition app, and wanted it to offer information about how to overcome barriers to healthy eating (limited time to plan meals, limited dining hall options, and high academic stress). The majority (75%) of athletes were either extremely interested or very interested in individual nutrition goals, meal planning and food preparation ideas, and recipes for sports snacks that were high in protein and carbohydrate. (P28-007-20 Frith)

■ People who want to lose weight commonly believe they have to add on exercise to burn off additional calories. In a study with 383 participants (mean age 45 y; BMI 32), those who followed 1,200 kcal to 1,800 kcal diets with no exercise, moderate exercise (150 min/wk) or high exercise (250 min/wk) all lost similar amounts of weight at 12 months. Those who did no exercise (diet alone) lost about 10 kg, similar to the 11 kg lost with diet + moderate exercise, and the 9.5 kg lost with high exercise. The researchers noted that exercise did not enhance weight loss, although no mention was made about changes in body fatness. (P28-014-20 Liguori)

Currently, *Nutrition 2021* is slated for July 10-13 in Boston, perhaps with a robust virtual component given the success of *Nutrition 2020 Live Online*. Will ASN have started a new trend that allows for greater access to world-class nutrition programming without travel expenses for the participants?

"Conference Highlights" editor Nancy Clark, MS, RD, CSSD has a private practice in the Boston area. The latest edition of ***Nancy Clark's Sports Nutrition Guidebook*** *was released in 2019. For more information, visit www.NancyClarkRD.com.*

Research Digest

Effects of Dietary Intake on Exercise-induced Muscle Damage

Mielgo-Ayuso J, Calleja-Gonzalez J, Refoyo I, et al. Exercise-induced muscle damage and cardiac stress during a marathon could be associated with dietary intake during the week before the race. *Nutrients*. 2020;12:2-16.

Although exercise-induced muscle damage (EIMD) and exercise-induced cardiac stress (EICS) are common in marathon runners, the extent of both EIMD and EICS is highly variable and influenced by many factors. The purpose of this study was to examine the effects of pre-race dietary intake on EIMD and EICS in male recreational runners. In this observational study, 69 male recreational marathon runners completed a 7-day weighed food record one week prior to the marathon race. Race day dietary intake was also recorded. Serum markers of EIMD (creatine kinase [CK]) and EICS (cardiac troponin [TNT]) were measured immediately post-race. Results indicate marathon runners consumed approximately 44.8 ± 6.2 kcal/kg/d, 5.04 ± 0.89 g carbohydrate/kg/d, 1.94 ± 0.36 g protein/kg/d, and 1.81 ± 0.35 g fat/kg/d prior to the race. Vegetable (P=.002) and fish (P=.042) intake were negatively associated with CK, whereas meat (P< .01) was positively associated with CK. Both olive oil (P<.01) and fish (P=.002) intake were negatively associated with TNT. However, butter and fatty meat (P<.001) were positively associated with TNT. In conclusion, fish, vegetables, and olive oil consumed the week prior to a marathon were associated with less EIMD and EICS, whereas meat, butter, and fatty meat were associated with increased EIMD and EICS. Athletes should be encouraged to increase consumption of fish and vegetables and olive oil prior to a race as part of a general healthy diet with the potential to decrease EIMD and EICS.

Summarized by Ian Bryant, undergraduate student in nutrition, sports nutrition concentration, Department of Nutrition and Exercise Sciences, Weber State University, Ogden, UT.

Nutritional Intake in Elite Cross-Country Skiers

Carr A, McGawley K, Govus A, et al. Nutritional intake in elite cross-country skiers during two days of training and competition. *Int J Sport Nutr Exerc Metab.* 2019;29:273-281.

Elite cross-country skiers perform sustained high-intensity exercise during competition and training. Adequate macronutrient and fluid intake are crucial for optimal performance. The purpose of this study was to describe the diet of elite cross-country skiers during a training day (Day 1) and a simulated sprint competition day (Day 2). In this observational study, 31 Swedish national junior and senior cross-country ski racers completed a weighted food record one day prior to a cross-country skiing sprint competition (Day 1) and the day of the sprint race

(Day 2) and waking urine samples on these same days. The weighted food records were analyzed for energy and macronutrient compositions and fluid intake. Urine specific gravity (USG) of waking urine samples from Days 1 and 2 was used to assess hydration. Total daily energy intake on Day 1 was higher than Day 2 for males (65 ± 9 kcal/kg vs. 58 ± 9 kcal/kg, *P*=.002), but similar for females (57 ± 10 kcal/kg vs. 55 ± 5 kcal/kg, *P*=.445). Approximately 89% of males and 92% of females did not consume adequate carbohydrate (10-12 g/kg) on Day 1 (8.2 ± 2.3 g/kg and 7.0 ± 1.5 g/kg, respectively). Although athletes consumed more carbohydrate on day 2 compared with Day 1, 72% of males and 85% of females had intake below recommendations (8.9 ± 2.3 g/kg and 8.5 ± 1.7 g/kg, respectively). Both male and female athletes were found to consume more protein than the daily recommendation (1.2-2.0 g/kg) on both training day (3.6 ± 0.5 g/kg and 3.0 ± 0.6 g/kg) and competition day (3.3 ± 0.6 g/kg and 2.8 ± 0.4 g/kg). Average fat intake for male and females was adequate (20%-35% of total energy intake) on both days. USG results indicated that dehydration was common among athletes (50% and 56% of males, 46% and 38% of females on Day 1 and Day 2, respectively.) This study suggests that cross country skiers should prioritize and increase carbohydrate and fluid intake during training and competition days. Carbohydrate intake should be increased during training sessions and competition through food or fluids. No external funding was received for this study.

Summarized by Kiley Allman, undergraduate student in nutrition, sports nutrition concentration, Department of Exercise and Nutrition Sciences, Weber State University, Ogden, UT.

Clean Eating and Disordered Eating

Ambwani S, Shippe M, Gao Z, et al. Is #cleaneating a healthy or harmful dietary strategy? Perceptions of clean eating and associations with disordered eating among young adults. *J Eat Disord*. 2019;7:17.

Given the established relationship between dieting behaviors and disordered eating, nutrition professionals need to remain aware of new dieting trends. This study examined "clean eating" diets that have recently been popularized, especially by social media. Researchers aimed to uncover any associations between perceptions of "clean eating" diets and clinical indicators of eating disorders. Study participants (n=148) were undergraduate students, primarily female (n=104) and white (60.1%), with a mean age of 19 years. Participants first completed five questionnaires related to body image, eating patterns, and clinical phenomena associated with eating disorder pathology. Participants then evaluated a series of five vignettes. Each vignette was a photo taken from the Instagram platform depicting one version of a "clean eating" diet as popularized by social media including alkaline, vegan, gluten-free, meal substitution, and a "new" balanced diet (based on USDA 2015-2020 *Dietary Guidelines for Americans*). Attached to each photo was a narrative of a protagonist implementing each diet in a strict regimen that caused obvious distress and dysfunction. Participant-perceived ratings of "healthiness," "cleanliness," and "willingness to adopt" for each diet vignette were found to be positively associated with symptoms of orthorexia nervosa (*P*<.01), symptoms of eating disorder (*P*<.01), and overweight preoccupation (*P*<.01). These findings demonstrate the need for nutrition professionals to be aware of the potential for implementing a "clean eating" style as a façade for disordered eating patterns. This research was supported by grants from Dickinson College, Ellen Feldberg Gordon Challenge Fund for Eating Disorders Prevention Research, and the Maternal and Child Health Bureau.

Summarized by Kylee Sexton, graduate student, Department of Nutrition and Integrative Physiology, Coordinated Master's Program, Nutrition, Education and Research Concentration, University of Utah, Salt Lake City, UT.

Sleep Loss and Metabolic Regulation

Wilms B, Leineweber EM, Mölle M, et al. Sleep loss disrupts morning-to-evening differences in human white adipose tissue transcriptome. *J Clin Endocrinol Metab*. 2019;104:1687–1696.

During the past few decades, the rate of obesity has increased while the average sleep duration has decreased. There is limited understanding of the link between sleep restriction and metabolic regulation. This study aimed to distinguish the effect of sleep curtailment on morning-to-evening white adipose tissue (WAT) transcriptome regulation and its metabolic ramifications. Fifteen healthy men between the ages of 18 to 30 years completed of three separate overnight stays with different sleep durations. In a randomized crossover design, the study participants were assigned to a regular 8 hours of sleep between 11:00 pm and 7:00 am, restricted sleep of 4 hours between 3:00 am and 7:00 am, and complete sleep deprivation. WAT biopsies were taken at 9:00 pm and 7:00 am each stay to analyze circadian core clock gene expression and RNA sequencing. Metabolic factors such as glucose homeostasis, lipid profile, and adipokines were evaluated. Results of time regulated/highly sleep sensitive genes suggest a strong effect of sleep on the regulation of energy metabolism via adipose metabolism (70 genes; *P*<.001), oxidative phosphorylation (18 genes; *P*<.001), and ubiquitin-mediated proteolysis (15 genes; *P*=.0001). Furthermore, one night of sleep restriction or deprivation showed a reduction of insulin secretion (*P*< .05). These data provide a possible causation between sleep loss and obesogenic effects. Sleep duration and timing may be a key division missing from prevention strategies against metabolic disorders. Further research is needed to clearly distinguish the relationship between sleep and circadian influence on the WAT transcriptome. This research was supported by grants of the German Research Foundation.

Summarized by Kasie Gloschat, graduate student, Department of Nutrition and Integrative Physiology, Coordinated Master's Program, Nutrition, Education and Research Concentration, University of Utah, Salt Lake City, UT.

Payment Matters!

Know Where the Money Comes From, Even If You Collect a Salary

by Carol Bradley, PhD, RDN, FAND

Have you ever asked what the Academy is doing for you to get a better salary? I can't help being shocked when one of our peers won't pay dues to the Academy because they "can't afford it," or they think the "Academy is not doing enough for them." What? In reality, the Academy is doing much on members' behalf to empower them in the area of reimbursement.

For several years, the Nutrition Services Coverage Team of the Academy has been working tirelessly behind the scenes to provide us with the tools to advocate and negotiate for ourselves for improved payment for our services. Even if you don't think it applies to you now, we have strength in numbers.

Another place where numbers matter is in the number of us who sign up for our own provider numbers, known as National Provider Identifiers (NPIs). The more registered dietitian nutritionists (RDNs) who have NPIs, the better it is for all. It indicates to the Centers for Medicare and Medicaid (CMS) how many of us there are, even if you don't currently practice medical nutrition therapy (MNT). To receive reimbursement, or as it is more correctly now called, payment for services, you must have an NPI number and either assign it to yourself or assign it to your facility.

Sign Up for the Power of Payment Program!

The Academy's **Power of Payment** program is an email series that will help you be successful, no matter where you work. When you understand where the money comes from and how to leverage it, you are better positioned to negotiate pay, create a job, advocate for more staff, build a successful private practice, and increase RDN presence and influence within an organization.

Through **Power of Payment**, you will learn about multiple sources of payment for your services, including payments from health insurance. Understanding funding sources and/or the mechanics of health insurance payments can help you and your organization avoid losing money and thrive in an evolving marketplace. Furthermore, your knowledge about the financial value of the services you provide will help you secure your future and the future of the profession.

What's in it for you if you register for this program? **Power for Payment** can empower you to grow your client/patient base and revenue by knowing the untapped sources of payment for you or your practice. Signing up for **Power of Payment** also gives you free access to *MNT Provider Newsletter*, a monthly practice management publication specifically tailored for nutrition professionals. To explain the program and its impact on you, the Academy's Nutrition Services Coverage team has created a video you can access at https://and.informz.net/AND/pages/Power_of_Payment_Program.

You can also access helpful payment information to help grow your practice by:

1. Learning about the health insurance mix of your state's population or in neighboring states.

2. Making a list of potential payers to explore now or in the future.

3. Visiting websites of your own health care provider(s), of family members, or medical practices or systems in your area and/or area of interest.

If you haven't done so already, I urge you to sign up for **Power of Payment** today. For more information and to subscribe to this program, visit www.eatrightpro.org/payment. Please share this information with other RDNs and encourage them to sign up as well. It takes every one of us to move our profession forward to ensure more desirable payment for our services.

Carol Bradley, PhD, RDN, FAND is SCAN's reimbursement representative to the Academy.

Of Further Interest

News from Cardiovascular Health Subunit

Here are some announcements from the Cardiovascular Health (CV Health) subunit:

• Check Out Our Webinars. Visit www.scandpg.org to view our four previously recorded webinars from last year. The most recent one was held in June 2020: "*Current Evidence and Clinical Recommendations on the Effects of Low-Carbohydrate and Very-Low-Carbohydrate (including Ketogenic) Diets for the Management of Body Weight and other Cardiometabolic Risk Factors,"* by Carol Kirkpatrick and Susan Vannucci. As with all full-hour webinars offered by SCAN, you have the opportunity to earn 1 CPEU.

• Upcoming CV Health Webinars. Here are our four exciting webinars coming up in 2020 and early 2021: (1) *Cardiovascular Nutrition Assessment Update: A New Assessment Tool,* November 4, Noon CST, by Ellen Aberegg and Karen Collins; (2) *2019 ACC/AHA Lifestyle Recommendations for the Treatment of Hypertension and the Role of Medical Nutrition Therapy*, December 9, 1 pm CST, by Kim Larson; (3) *Omega 3 Fatty Acids and Cardiovascular Disease Prevention: An Update*, February 10, 1 pm CST, by Kevin Maki; and (4) *The 2020 US Dietary Guidelines: A Focus on CVD Prevention,* April 28, 1 pm CST, by Linda Vanhorn.

• CV Health Webbies. SCAN's Webbies—action-focused education tools that run 3 to 5 minutes in length—enable members to increase their expertise one skill at a time. The first CV Webbie of 2020, *Is Saturated Fat Associated with Clogging the Arteries?* by Nancy Smith, was posted in July. Visit www.scandpg.org to view the following CV Health Webbies currently posted from last year: (1) *To Egg or Not To Egg: Eggs and CV Health*, by Geeta Sikand; (2) *Coconut Oil Controversy: Is the Jury Still Out?* by Sharon Smalling; (3) *So How DO Plant Sterols and Stanols Lower Cholesterol?* by Julie Bolick; (4) How *Does Viscous Fiber Lower Cholesterol?* by Karen Collins; (5) *Omega 6s and Heart Health—The Truth Revealed,* by Kevin Maki; and *(6) Is Saturated Fat Associated with Clogging the Arteries?* by Nancy Smith. If you have an idea for a Webbie, contact Geeta Sikand, director of the Cardiovascular Health subunit, at gsikand@gmail.com.

• CV Reimbursement Trends and Efforts. Carol Bradley, SCAN's reimbursement representative to the Academy, explains on page19 of this issue how the Power of Payment program can benefit you. If you're interested in becoming involved in our efforts to increase awareness of reimbursement issues and topics, contact Geeta Sikand at gsikand@gmail.com.

• We Need Volunteers. If you'd like to serve on the CV Health subunit committee by sharing your expertise, updating CV Health Resources on the SCAN website, and/or serve on the CV Reimbursement Committee, contact Geeta Sikand at gsikand@gmail.com.

News from Wellness & Wellbeing Subunit

Following is a news update from the Wellness & Wellbeing subunit:

• We Welcome Your Webinar Input! Do you have an idea for, or are you interested in, writing a webinar or a mini-webinar (Webbie) for the Wellness & Wellbeing subunit? If so, contact Mark Hoesten, director of the Wellness & Wellbeing subunit, at mshcg@yahoo.com.

• New and Upcoming Webinars. Check out our latest webinar, *Cultural Competency/Humility*, which was recently released on www.scandpg.org. Then be on the lookout for our next new webinar, *Honing Your Skills for Virtual On-Line Patient Care,* coming in early 2021.

News from the Sports Performance Subunit

Below are some highlights from the Sports Performance subunit:

• Updated Online Sports Nutrition Care Manual®. Have you seen the updated version? A full webinar developed by Kate Davis, MS, RD, CSSD will be available for you to learn about all of the numerous ways to utilize this newly updated tool. Check it out now at www.nutritioncaremanual.org/sports-nutrition-care.

• SCAN Fact Sheets. Check out the newest SCAN fact sheets at. www.scandpg.org/scan/educational-resources/fact-sheets/sn-fact-sheets Download them for free today!

• Athletes and the Arts Partnership. SCAN has an official partnership with Athletes and the Arts (an initiative of the American College of Sports Medicine). This ties in with our Expanding the Arena Initiative by promoting opportunities for sports dietitians to work with performing artists. We're looking for volunteers who are interested in developing this partnership. Visit the SCAN volunteer page at www.scandpg.org/scan/about-us/volunteer-opportunities today!

• New! Changes to the CSSD Exam Window. The CSSD exam is now administered year-round! Visit the Commission on Dietetic Registration (CDR) website at www.cdrnet.org/certifications/board-certification-as-a-specialist-in-sports-dietetics for more information.

Call for Abstractors for "Research Digest"

The "Research Digest," which appears in each issue of *SCAN'S PULSE,* provides summaries of published papers relating to all of SCAN's practice areas: nutrition for sports and physical activity, cardiovascular health, wellness, and disordered eating and eating disorders.

You can contribute to the "Research Digest" by volunteering to abstract a recently published study on any of the above practice areas. For details on this opportunity, contact Kary Woodruff, MS, RD, CSSD, co-editor of "Research Digest," at kary.woodruff@health.utah.edu. Become a contributor to *PULSE*

Upcoming Events

NOTE: Due to the coronavirus pandemic, the details below regarding virtual versus in-person events may change. Please be sure to check the links below for updated information.

October 17-20, 2020

Food & Nutrition Conference & Expo™ (FNCE®) 2019, virtual event. The SCAN Spotlight Session will be "Soft Tissue Health: Nutritional Strategies for Injury Prevention and Recovery." For information: https://eatrightfnce.org/attend/registration/

November 13 – December 14, 2020

Annual Renfrew Center Foundation Conference for Professionals, *Feminist Relational Perspectives & Beyond: Lessons Learned,* virtual event. For information: https://renfrewcenter.com/renfrew-center-foundation/renfrew-conference

December 13-16, 2020

National Lipid Association Science Sessions, Chicago. For information: https://www.lipid.org/sessions

March 4-8, 2021

Join your colleagues at the 37th Annual SCAN Symposium, Boston, MA. For more information: www.scandpg.org/symposium-2021/

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Appropriate announcements are welcome. Deadline for the Spring 2021 issue: Dec. 1, 2020. Deadline for the Summer 2021 issue: March 1, 2020. Manuscripts (original research, review articles, etc.) willl be considered for publication. Guidelines for authors are available at www.scandpg.org/nutrition-info/pulse/ Email manuscript to the Editor-in-Chief; allow up to 6 weeks for a response.

Subscriptions: For individuals not eligible for Academy of Nutrition and Dietetics membership: $50. For institutions: $100. To subscribe: SCAN Office, 800/249-2875

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