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DIET

ABSTRACT & COMMENTARY

Diet and Global Mortality

By David Kiefer, MD, Editor

Clinical Assistant Professor, Department of Family Medicine, University of Wisconsin; Clinical Assistant Professor of Medicine, Arizona Center for Integrative Medicine, University of Arizona, Tucson

Dr. Kiefer reports no financial relationships relevant to this field of study.

SYNOPSIS: Worldwide, there are alarming trends in unhealthy eating habits, which account for significant morbidity and mortality.

SOURCE: GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990-2017: A systematic review for the Global Burden of Disease Study 2017. *Lancet* 2019;393:1958-1972.

Those of us in clinical practice are well-versed in addressing tobacco use and maximizing antihypertensive therapy. There are known, convincing consequences to those behaviors and conditions. Also, we are no strangers to the importance of nutrition. Most of us have grown up with "you are what you eat," and there is now a large body of research to back that up, such as the Mediterranean diet and other nutritional approaches to health and disease. In recent years, authors for *Integrative Medicine Alert* have showcased these nutritional data. But what would it take to have food and nutrition take its place at the dinner table of major governmental guidelines, health policy decision-making, and the forefront of clinician-patient discourse? Perhaps the epidemiological study by the GBD 2017 Diet Collaborator research group, funded by the Bill and Melinda Gates Foundation and published in the April 3, 2019, edition of *The Lancet*, will serve that role.

To analyze the effect of diet on health, the researchers collected data on the intake of 15 foods and nutrients consumed by adults (25 years of age or older) in 195 countries. Their goal was to connect diet to chronic disease burden, so they also pooled data about mortality from noncommunicable diseases rather than death by other causes that may

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Summary Points

- A global survey of 15 dietary factors (some positive, some negative) showed trends in unhealthy eating across geographic and demographic lines.
- An estimated 11 million people died in 2017 because of suboptimal eating habits.
- Most of the global diet-related health burden stemmed from high sodium intake and low intake of fruits and whole grains.

not be so closely tied to nutrition. The dietary factors chosen already had some data for a connection to health outcomes. (*See Table 1.*)

Global surveys, primarily based on the 24-hour dietary recall, were searched to collect data on the consumption of these dietary factors for countries or smaller geographic areas using a variety of sources as detailed in the article. When possible, household budget information was noted, as were sales data (i.e., hydrogenated oils) or quantified physical data (i.e., urinary sodium). At times, the researchers had to estimate (guess-timate?) gender and age-specific results, extrapolating from nutritional data available for a country to the age/gender breakdowns for that country. Estimates were made based on the medical literature for each dietary factor's optimal intake, and then whether people in each country were eating more or less of that nutrient or factor.

Then, the researchers paired dietary factors with a multitude of diseases and turned to the medical literature for quantified effects on mortality and morbidity. For some health conditions, such as type 2 diabetes and cardiovascular disease, they were able to specify the dietary effect on that disease process by age. Some estimates were indirect, such as the dietary effect of sodium. Urinary sodium implied excess sodium consumption, which is known to adversely affect blood pressure, and it is the hypertension literature that allowed a disease connection to be made. The researchers wove in diet, disease, age, gender, and year to comment on the mortality, as well as disability-adjusted life-years (DALYs).

The results showed that global intake of what the researchers called "healthy foods" was less than ideal; the lowest intakes were for whole grains, nuts, and milk. Geographically, the low-healthy-food trend was consistent across regions, except for adequate vegetable intake in central Asia, omega-3s in high-income areas of the Asian Pacific, and legumes in the Caribbean. In contrast, the "unhealthy" foods were ingested in amounts much higher than optimal levels, especially for sweetened beverages, sodium, and red and processed meats. Both types of foods (healthy and unhealthy) were consumed more by men and adults 50 to 69 years of age.

With respect to mortality and morbidity correlates, nutrition was linked to 11 million deaths globally in 2017,

Table 1: 15 Dietary Factors Analyzed in This Global Disease Burden Study

Low Intake of …	High Intake of …
• Fruits • Vegetables • Legumes • Whole grains • Nuts and seeds • Milk (dairy source) • Fiber • Calcium • Seafood omega-3 • Polyunsaturated fatty acids	• Red meat • Processed meat • Sugar-sweetened beverages • Trans-fatty acids • Sodium

Table 2: Countries That Scored Highest and Lowest for Diet-Related Deaths and DALYs		
Deaths	Overall highest	Egypt
	Overall lowest	Japan
	Cardiovascular highest	China
	Cardiovascular lowest	Japan
	Cancer highest	China
	Cancer lowest	Egypt
	Type 2 diabetes highest	Mexico
	Type 2 diabetes lowest	Japan
Disability-adjusted life years (DALYs)	Overall highest	Egypt
	Overall lowest	Japan
	Cardiovascular highest	Egypt
	Cardiovascular lowest	Japan
	Cancer highest	China
	Cancer lowest	Egypt
	Type 2 diabetes highest	Mexico
	Type 2 diabetes lowest	Japan

10 million of which occurred because of cardiovascular disease, and almost 1 million from cancer. All told, this was estimated to be 22% of all adult deaths. The researchers also calculated that 225 million DALYs occurred because of nutritional reasons. The greatest negative effect of nutritional habits occurred in Oceania, whereas high-income Asia Pacific had the least rates of diet-related deaths and Australasia had the lowest rate of DALYs that occurred because of nutrition. By country, some standouts by category were apparent. (*See Table 2.*) The authors provided impressive color-coded charts and maps detailing these results, as well as some of the regional and disease-specific nuances by dietary factor.

Some nutrients were more important than others. Half of the deaths, and more than half of the DALYs, were attributable to high sodium intake and low fruit and whole grain consumption. There were some regional differences in nutrient intake that contributed to health outcomes, such as high sodium intake in Asia, low fruit intake in sub-Saharan Africa, and low intake of nuts and seeds in Latin America. Incredibly detailed colorized pie charts explored these geographic variations.

The authors concluded that "…dietary risks affected people regardless of age, sex, and sociodemographic development of their place of residence."

■ COMMENTARY

The researchers involved in this project confirmed on a global level what all people, whether in healthcare or not, know: Healthy nutrition is extremely important for health promotion and disease prevention. There were noted effects of eating less of the "healthy foods" and not enough of the "unhealthy foods" in all regions and for all age groups, but some areas had specific nutrient concerns. Perhaps there are cultural or economic factors that lead to, for example, suboptimal fruit intake in Sub-Saharan Africa or elevated sodium in Asia. If these results are to be believed, it would behoove both policymakers and healthcare practitioners to pay attention to these particular "weak links" and address them as the scope of their occupation allows.

Yes, this was an ambitious epidemiological study, as thorough as it could have been given the enormous scope of the project. The comprehensiveness of the survey sources was impressive, seemingly leaving no stone unturned. For example, it was impressive that the authors tied dietary sodium, when possible, to urinary sodium laboratory findings. That said, a study like this is only as good as the data available, and not all countries presumably had the facts necessary for a perfect analysis. Can we apply these results to the patients we see in clinic every day? Possibly. Does it provide some overarching themes and trends to help nudge our nutritional thinking on many healthcare levels? Definitely.

Obviously, the dietary connection to morbidity and mortality is one meaningful takeaway from this work. Another offshoot of their work is that they were able to estimate the "optimal intake" for a given nutrient, perhaps a guide for our patients

interested in more specifics by nutrient. The table in their article provides these data and would be a useful reference for clinicians and patients alike, prompting the need for us non-metric users to convert some numbers.

The 15 dietary factors list also could be a starting point in discussing nutrition with patients. A wallet-size version, or even a poster on the clinic wall splitting the dietary factors into "Yes, eat more of these!" and "Please try to minimize these" could be a simple, risk-free nutritional step in the right direction for all of us. Furthermore, there is something empowering in thinking about the fact that "we're all in this together," that everyone around the globe, with some local particularities, is struggling with diet-related disease effects, hopefully ready to shift our food choices to the positive. This article may be the reminder, with some specific suggestions, about just how to do that. ■

FALLS

ABSTRACT & COMMENTARY

Preventing Injurious Falls With Tai Ji Quan or Exercise in At-Risk Populations

By Ellen Feldman, MD

Altru Health System, Grand Forks, ND

Dr. Feldman reports no financial relationships relevant to this field of study.

SYNOPSIS: In this three-arm study, a therapeutic form of Tai ji quan is superior to either a multimodal exercise or a stretching program in reducing severe injurious falls among at-risk older, community-dwelling Americans.

SOURCE: Li F, Harmer P, et Eckstrom E, et al. Effectiveness of Tai ji quan vs multimodal and stretching exercise interventions for reducing injurious falls in older adults at high risk of falling: Follow-up analysis of a randomized clinical trial. *JAMA Netw Open* 2019;2:e188280.

The top cause of injury in older Americans is falls. Reported in almost 30% of community-dwelling adults older than 65 years of age, the economic effect of this potentially preventable problem is considerable and growing. In 2015, the healthcare-related cost of falls was $50 billion yearly, and it is projected to reach almost $70 billion by 2020 as the population ages.[1,2]

Researchers have determined that exercise is helpful in reducing the severity and incidence of falls, but evidence-based investigations with specific recommendations regarding the type and frequency of optimal intervention are in short supply. To address this growing public health problem, Li et al set the goal of determining if Tai Ji Quan: Moving for Better Balance (TJQMBB) was more effective and efficient than other more conventional exercise programs for preventing falls in the at-risk population and, more specifically, for preventing falls resulting in moderate to severe injuries.

Tai ji quan, also known as tai chi, has evolved into multiple branches and styles since originating more than 300 years ago in the Henan province in China. Moving away from its origins under the general umbrella of martial arts, this stylized mind-body technique involving movement, breath, and spirit is recognized widely for its inherent health benefits.[3] This work by Li et al is a follow-up to an earlier published study describing a six-month randomized, controlled trial involving TJQMBB, a multimodal exercise program (MME), and a stretching program.[3] The authors randomized 670 older adults meeting inclusion criteria to one of three study arms: TJQMBB, MME, or stretching exercises. All interventions occurred twice weekly for 60 minutes.

Eligible participants included community-dwelling adults 70 years of age or older who either had fallen in the year preceding the study, had a health provider referral indicating an elevation in fall risk because of recent falls or other factors, or had measurable impaired mobility indicated by a standardized timed test (Timed Up and Go).

In this original six-month study, both TJQMBB and MME were significantly superior to the stretching exercise program for reducing falls in an at-risk population. When comparing the TJQMBB and MBB groups head to head at six months, fall rates in the TJQMBB group were 31% lower than in the MBB group.

Li et al continued the study past the intervention phase for a six-month follow-up period, during

Summary Points

- Li et al randomized 670 older adults determined to be at high risk of falling into one of three interventions: Tai Ji Quan: Moving for Better Balance (TJQMBB), multimodal exercise (MME), or stretching exercise program.
- The primary outcome was incidence of moderate to severe injurious falls at 12 months, representing the culmination of a six-month period of active intervention and six months of follow-up.
- There were 102 serious injurious falls documented in the entire group: 15 in the TJQMBB arm, 32 in the MME arm, and 55 in the stretching group.
- For moderate injurious falls (strains or sprains but no hospital admission), the TJQMBB and MME groups both showed significant advantage over the stretching exercise group. There was no significant difference between the two interventions (TJQMBB and MME).
- For severe injurious falls (hospital or emergency department admission), both the TJQMBB and MME groups showed a significant advantage over the stretching group. The TJQMBB group also showed a significant greater reduction in these types of falls vs. the MME group.

which time there was no active intervention. The group collected data monthly and analyzed the incidence of moderate and injurious falls among the participants at the end of 12 months (six-month intervention and six-month follow-up).

In the study protocol, all participants were asked to maintain a daily "fall calendar." Attrition and drop-out from the study was low across all groups; at the end of 12 months, data for outcomes was available from 94.6% of the group.

INTERVENTIONS

TJQMBB is a specialized program, derived from tai chi (more properly known as Tai ji quan) and developed specifically as a therapeutic intervention for fall prevention. It incorporates eight modified Tai ji quan exercises and maintains a focus on breathing and movements, emphasizing weight shifting, balance, alignment, and rotation. MME involved a structured combination of aerobic exercise and interventions geared toward increased flexibility, strength, and balance. This group began using gym machines and tools such as hand weights by month 4. The stretching exercise intervention included breathing, stretching, and relaxation programs, mostly in a seated or prone position. All interventions were twice weekly for 60 minutes for 24 weeks. Each intervention included a standard structure of warm-up, core exercise, and cool-down.

RESULTS

Moderate injurious falls were defined as falls resulting in sprains, strains, or abrasions without the need for medical assistance or care. Severe injurious falls were falls resulting in hospitalization or an emergency department encounter. Records documenting the visit were collected when available.

Table 1 depicts incident rate ratios (IRR) adjusted for multiple covariates, including age, health status, number of falls prior to the study, and level of exercise after the six-month intervention period. Notably, the groups practicing TJQMBB and MBB showed a reduction in moderately injurious and severe injurious falls when compared with the stretching group. When comparing the TJQMBB and MME arms head to head, there was no significant difference in incidence of moderate injurious falls. When looking at severe injurious falls, there was a significant reduction of such falls in the TJQMBB group ($P = 0.03$). (*See Table 2.*)

■ COMMENTARY

Falls are the top cause of injury and death in older Americans and the second leading cause of accidental death worldwide.[1,2] Addressing this issue at the root of the problem requires developing a multipronged strategy; prevention must serve as the linchpin.

Li et al clearly recognized the importance of offering an evidence-based program to address fall prevention. Their work, published in two parts, is best viewed as one study progressing from a randomized, clinical trial looking at fall incidence among three intervention groups to a more nuanced look at the numbers by analyzing the incidence of injurious falls among these same three groups: TJQMBB, MME, and stretching.

The protocol used for the intervention groups attempted to match structure of the instruction and frequency. During the six-month follow-up period, information about exercise frequency revealed no significant differences between the three groups. It still is possible that subtle between-group differences in the delivery method or factors other than the

Table 1: Adjusted IRR After 6 Months of Intervention and 6-Month Follow-Up			
	Adjusted IRR	**95% Confidence Interval**	***P* Value**
Moderate Injurious falls Month 12: **TJQMBB vs. stretching**	0.53	0.36-0.76	0.001
Moderate Injurious falls Month 12: **MME vs. stretching**	0.65	0.45-0.94	0.02
Moderate Injurious falls Month 12: **TJQMBB vs. MME**	0.85	0.58-1.25	0.42
Severe Injurious falls Month 12: **TJQMBB vs. stretching**	0.25	0.13-0.48	< 0.001
Severe Injurious falls Month 12: **MME vs. stretching**	0.56	0.33-0.94	0.03
Severe Injurious falls Month 12: **TJQMBB vs. MME**	0.47	0.24-0.92	0.03
IRR: incident rate ratio; TJQMBB: Tai Ji Quan: Moving for Better Balance; MME: multimodal exercise program			

intervention itself were significant in affecting fall incidence. Future studies with larger numbers, more rigorous methods of controlling interventions, and more advanced mechanisms to quantify falls will be helpful in advancing this field.

Although perhaps inadvertent, this study puts a spotlight on the sheer number of injurious falls in at-risk community-dwelling older adults. The aftermath of falls may range from inconvenience to hospitalization, from disability to death — making the case for fall prevention quite compelling.[1,2] With 232 moderately injurious falls in the stretching group of 223 participants, it is clear that there was more than one fall per group member. Investigating the number of falls per person would be useful in further understanding the effect of each intervention and determining any subgroup more or less likely to respond.

With the significant reduction in severe injurious falls in the TJQMBB group at month 12, it is interesting to consider that there may be specific benefits in either fall prevention or strengthening from this intervention. As there was no significant difference between the TJQMBB group and the MME group in the incidence of moderate injurious falls, it may be that the TJQMBB intervention helped protect participants from more severe injuries even with a fall. Understanding more about the effect and protective mechanism of TJQMBB is a target for future studies in this area.

It is notable that the incidence of falls in all groups appeared high compared to the 30% rate typically seen in the general population of older adults. Most likely, this is because the study population included high-risk adults by definition (this was part of the eligibility criteria). As we consider prevention efforts, it would be interesting to see if a more diverse population of older adults would perform similarly. Likewise, as age is one of the global risk factors for falls, broadening the study to other age groups could trigger early prevention interventions.

At this point, the information we have points to a role for specialized exercise, perhaps derived from Tai ji quan, to assist with fall prevention programs in the at-risk community-dwelling older population. Li et al did not review other specialized exercise programs for fall prevention, but there are several previous studies confirming the utility of Tai ji quan training in fall prevention.[4] Citing these studies, the Centers for Disease Control and Prevention includes specialized forms of Tai ji quan (including TJQMBB) in the list of exercises for "effective fall prevention for community-dwelling older adults."[5]

Although there are not many studies exploring fall prevention for other groups, such as nursing

Table 2: Numbers of Falls and Number of Participants			
	Number of Participants	**Moderate injurious Falls After 12 months (*P* = 0.02)**	**Severe Documented Injurious Falls After 12 months (*P* = 0.001)**
TJQMBB	224	127	15
MME	223	148	32
Stretching Group	223	232	55

P values represent overall between-group differences in the mean number of falls in each category. The intervention groups have significantly fewer mean injurious falls than the stretching or control group.

TJQMBB: Tai Ji Quan: Moving for Better Balance; MME: multimodal exercise program

home residents or not yet at-risk patients, there is no reason to suspect that this type of intervention (modified Tai ji quan) cannot be helpful and convey protection in these and other populations. This study revealed no adverse effects from any of the interventions.

It seems a clear choice for providers to promote modified or other available Tai ji quan interventions to at-risk community-dwelling older adults and also to consider extending the recommendation to others who may fall outside this group. Partnering or establishing a basic familiarity with certified providers in the community may help assure quality and provide solid information about the types of Tai ji quan available for patients. ■

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DIET

SHORT REPORT

Attitudes Among Individuals Following Vegan, Vegetarian, and Omnivore Diets and Entomophagy (Insect Eating)

By Traci Pantuso, ND

Adjunct Faculty, Research Investigator, Bastyr University, Seattle

Dr. Pantuso reports no financial relationships relevant to this field of study.

SYNOPSIS: Insect consumption may be a solution to resource-intensive animal meat production in the future as global dietary protein demands increase. However, attitudes regarding insect consumption are not well understood.

SOURCE: Elorinne AL, Niva M, Vartiainen O, Vaisanen P. Insect consumption attitudes among vegans, non-vegan vegetarians, and omnivores. *Nutrients* 2019;11:E292. doi:10.3390/nu11020292.

Entomophagy, or insect eating, has been a common practice in particular cultural or regional groups throughout the world.[1,2] In China, specific cultural groups have consumed insects for more than 2,000 years for their medicinal and nutritional properties.[1] The United Nations Food and Agricultural Organization considers edible insects to be of value and a food source.[2] Traditionally, the Western world has not embraced the consumption of insects. Currently, entomophagy is experiencing popularity

Summary Point

- Vegans differ from non-vegan vegetarians and omnivores in their attitudes regarding insect consumption with a low willingness to consume insects.

as a potential sustainable alternative source of protein.[1-4] Dietary protein is pivotal to human health, and animal-based protein-dense foods are considered to be high-quality protein sources, as they are easily digested and absorbed and contain essential amino acids.[3,4] Unfortunately, the production of sufficient amounts of conventional animal-based protein-dense foods to meet global dietary demands may not be feasible, with the global population projected to reach 9.6 billion by 2050.[2]

Identifying sustainable protein sources that are culturally acceptable to meet dietary protein requirements is an important issue. Previous researchers have demonstrated that various social and cultural factors affect the acceptance of insects as food. For example, not much is known about vegans and non-vegan vegetarians and their attitudes toward insects as food. Along this vein, meat consumption has been shown to be affected by the demographics of the population studied. Meat consumption is higher in men than women, whereas higher education status and higher income are positively related to the adoption of plant-based diets. Elorinne et al hypothesized that vegans, non-vegan vegetarians, and omnivores have different attitudes toward the consumption of foods of insect origin and that vegans show less willingness to eat foods of insect origin than non-vegan vegetarians and omnivores.

The authors recruited participants involved in a large online survey in Finland. The online survey was a structured self-administered questionnaire. The request to respond to the insect consumption survey was delivered using social media and in digital versions of one national and one metropolitan area newspaper. A total of 567 consumers responded to the survey; 379 (67%) identified as women. In addition, 150 (27%) identified as some kind of vegetarian, and 417 (73%) identified as omnivores. The authors merged semi-vegetarians (n = 97), lactovegetarians (n = 25), and lacto-ovo vegetarians (n = 3) and labeled this group as the non-vegan vegetarians. The survey was comprised of four sections. The first section included background and demographic questions, the second section included the Food Neophobia Scale, and the third and fourth sections focused on attitudes, norms, behavioral control, and intentions. All questions were presented with the answer in the Likert scale format (1 = totally disagree, 7 = totally agree). At the end of the survey, participants were asked to answer an open-ended question on their reasons to eat or not eat foods of insect origin. To identify the underlying relationship between the measured variables, eight constructs were designed to measure the answers to the questions. These constructs were designed based on the internal consistency of the variables and also on the a priori hypotheses of the researchers. The eight constructs were intention, attitude, subjective norm, perceived behavioral control, healthiness, safety, convenience/price, and food neophobia in relation to insect consumption. Researchers analyzed the data using One-Way ANOVA and Chi-square test; a Bonferroni post-hoc test was used to analyze differences between the dietary groups.

More women (32 women) than men (16 men) identified as non-vegan vegetarians and vegans. Respondents who resided in cities had higher levels of non-vegan vegetarianism and veganism than those in rural areas. The vegan group significantly differed from the other groups in their attitude toward insect consumption, as they had a less positive attitude compared to the other groups. This attitude was significant between vegans and omnivores ($P < 0.001$), between vegans and non-vegan vegetarians ($P < 0.001$), and between omnivores and non-vegan vegetarians ($P < 0.05$). Non-vegan vegetarian attitudes were the most positive regarding insect eating compared to the other groups, but they were not significantly different from the omnivore group.

For the vegan group, social pressure was significantly less of a factor in food choice compared to the non-vegan vegetarians ($P < 0.001$) and omnivores ($P < 0.001$). Vegans also had significantly higher perceived behavioral control, with more agreement with statements measuring behavioral control (i.e., "I can easily control that my diet doesn't contain insects," "it is totally up to me whether I buy foods made of insects") compared to the non-vegan vegetarian ($P < 0.001$) and omnivore groups ($P < 0.001$). Vegans also demonstrated more fear of new foods than the other groups, with more agreement with statements (i.e., "if I do not know what the food contains, I won't try it" and "I am very selective in what I eat") compared to the omnivores, who had high agreement with "I will eat most anything." The vegan group significantly differed with the intention of non-vegan vegetarian ($P < 0.001$) and omnivore groups ($P < 0.001$) to eat foods of insect origin.

This article is interesting in that it demonstrates an openness among omnivores and non-vegan

vegetarians to consume foods of insect origin. Individuals who adhere to a vegan diet may be less likely to consume foods of insect origin. This is not surprising, as many vegans do not consume honey, which is a product of insects, and the fact that insects are animals. Much research needs to be conducted to understand the safety of insect foods, particularly the industrial scale of growing and processing, before they can be brought to market.[1] Another safety concern is the potential for insect contamination with a plethora of impurities, such as unsafe insects, elevated levels of heavy metals, toxins, pesticide residues, and pathogens. Best practices for safety testing in insects have not been established.[1] Once safety can be established, foods of insect origin have the potential to be a sustainable source of protein for humans.[1-4] ■

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DIET

ABSTRACT & COMMENTARY

Not Just Bulk: Dietary Fiber Crucial to Good Health

By Joseph E. Scherger, MD, MPH

Core Faculty, Eisenhower Health Family Medicine Residency Program, Eisenhower Health Center, La Quinta, CA; Clinical Professor, Keck School of Medicine, University of Southern California, Los Angeles

Dr. Scherger reports no financial relationships relevant to this field of study.

SYNOPSIS: Dietary fiber is crucial to maintaining a healthy gut microbiome. The microbiome helps determine our mental and physical health in ways that continue to be discovered.

SOURCE: O'Grady J, O'Connor EM, Shanahan F. Review article: Dietary fibre in the era of microbiome science. *Aliment Pharmacol Ther* 2019;49:506-515.

Advancing science tells us the microbiome is crucial for human health, both in body and mind. Denis Burkitt, an Irish physician and surgeon (1911-1993), famously said, "If you pass small stools, you have to have large hospitals."[1] Until recently, this expression was considered facetious; now, it seems prescient.

Traditionally, dietary fiber has been divided into soluble and insoluble. O'Grady et al reviewed the literature on the interplay of dietary fiber with the human microbiome and resultant metabolic effects. They described three more appropriate biologic effects of fiber: solubility, viscosity, and fermentation. Solubility refers to whether the fiber dissolves in water. Viscosity refers to the consistency of fiber and its effects on digestion, absorption, and satiety. For example, the common fiber supplement psyllium delays the degradation and absorption of nutrients and can reduce total glucose and cholesterol absorption by up to 12%.[2] Fermentation of fiber by the gut microbiota yields short-chain fatty acids that provide energy and exert an immunoregulatory and gut-brain signaling role.[3]

Summary Point

- Fiber has been shown to increase stool bulk; stimulate peristalsis; lower glucose, cholesterol, and triglyceride levels; and slow digestion and absorption.

O'Grady et al listed the following dietary fiber subtypes, their sources, and their metabolic effects: cellulose, hemicellulose, lignin, gums, pectin, beta-glucan, inulin, psyllium, oligosaccharides, and resistant starch. All fiber subtypes come from plants. The metabolic effects include increasing stool bulk; stimulating peristalsis; lowering glucose, cholesterol,

and triglyceride levels; slowing digestion and absorption; and providing the benefits of fermentation by the microbiota.

Current recommendations from the Academy of Nutrition and Dietetics (formerly known as the American Dietetic Association) call for 14 g of fiber for every 1,000 kcal consumed, or about 25 g for women and 38 g for men daily.[4] Current fiber consumption in the United States is estimated at only 12-18 g/day.[5] Ancestral humans consumed an estimated 100 g of fiber per day.[6] No wonder Burkitt referred to the United States as a "constipated nation."[1]

■ COMMENTARY

The evolutionary biologist Daniel Lieberman considers modern man in an industrialized culture in a state of disevolution.[7] Only recently have we begun to understand the health costs associated with consuming highly processed foods. The good news is that natural plant foods are available to everyone in the United States and elsewhere in supermarkets. Eating an adequate amount of fiber requires education and choices. The gut microbiome plays a major role in determining our mood and physical health. The benefits of a healthy microbiome go far beyond lowering the rate of colon cancer. Primary care physicians should play a leading role in advising patients to eat a diverse number of plants with healthy fiber, some of which also are referred to as prebiotics. ■

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SLEEP

ABSTRACT & COMMENTARY

Late Sunsets, Sleep Deprivation, and Adverse Outcomes

By Alan Z. Segal, MD

Associate Professor of Clinical Neurology, Weill Cornell Medical College

Dr. Segal reports no financial relationships relevant to this field of study.

SYNOPSIS: All living organisms have 24-hour circadian rhythms. A body of evidence is accumulating that chronic disruption of this important rhythm may result in poor health outcomes. These negative consequences of disrupted circadian rhythms might be prevented by modifying work and sleep schedules.

SOURCE: Guintella O, Mazzonna F. Sunset time and the economic effects of social jetlag: Evidence from US time zone borders. *J Health Econ* 2019;65:210-226.

Circadian rhythms are present in every living thing. Even simple prokaryotes, such as cyanobacteria, modulate their metabolism based on the wavelength of exposed light. In 2017, the Nobel Prize for Medicine was given to researchers who unlocked the molecular and genetic basis of circadian functions in the drosophila fruit fly. There are multiple determinants of circadian function (known as "zeitgebers," or timekeepers), the most important of which is blue light. The supraoptic nucleus of the hypothalamus is regulated directly by the intensity and timing of exposure to light. Melatonin (the hormone of darkness) is produced by the hypothalamus and is another important circadian regulator.

Summary Points

- Appetite and weight are linked to circadian function.
- Circadian rhythms affect immune and inflammatory regulation and probably modify the epigenetic modulation of DNA.

Beyond melatonin, multiple hormones cycle on a circadian basis, the most important of which are cortisol and growth hormone. Hypothalamic temperature regulation also follows a circadian pattern, with a typical body temperature nadir occurring three hours before waking. Appetite and weight are linked to circadian function, including the effects of leptin (which promotes satiety) and ghrelin (which increases hunger). Circadian rhythms affect immune and inflammatory regulation and likely modify the epigenetic modulation of DNA.

Despite these factors, human society has attempted to wrestle control over the circadian clock by creating work schedules (particularly night shifts) that contradict cycles of natural light. While "jet lag" is a transient travel-related disruption in sleep-wake schedules, "social jet lag" is a more chronic process, ingrained in the habits of our daily lives.

Although the Earth's rotation takes 24 hours, experiments in humans deprived of natural light or among the blind who cannot detect any light, show that the circadian cycle actually could extend to 24.5 or even 25 hours. Desynchronization between the circadian and "ultradian" cycles results in a disorder known as "hypernychthemeral syndrome" or "non-24," in which small alterations in cycle length add up from day to day, resulting in significant disruptions in sleep-wake cycles. Research in this area is challenging, as subjects in an experimental "free running" paradigm must spend days sequestered in a state of constant dim light exposure, deprived of TV or any other external cue of day or night.

Time zones are one example of a human construct superimposed on the natural variations of day and night. Within any given time zone, sunset times are not constant, but rather get progressively later as one proceeds westward, with the latest sunset being at the utmost western border of each zone. Over this western time zone boundary, sunset shifts an hour earlier as the clock is turned back. Despite these sunset differences, work, school, and social schedules remain fixed, with rigid morning starting times regardless of location within a time zone. Exploiting these variations, the authors compared sleep times (using data derived from Fitbit-type devices) across each of the four U.S. time zones. Sleep was studied geographically at the county level and ZIP code level, and as a continuous variable across the time zone. Data were derived further from the American Time Use Survey (ATUS) and Behavioral Risk Factor and Surveillance Survey (BRFSS).

Living on the "late sunset" (westernmost) side of a time zone resulted in an average of 19 fewer minutes sleep per night compared to living at the easternmost sector of the next time zone. Alternatively, using eight hours as an "optimal" sleep duration, the "late sunset" cohort was 8% less likely to achieve the necessary amount of sleep.

The subjects were divided into "employed" (which included students) and "non-employed." Both groups were affected by "social jet lag," but in different ways. Living at the westernmost sections promoted late bedtimes, but this effect was more pronounced in the non-employed. While the employed were 34% more likely to be awake at midnight, the non-employed were 41% more likely to be awake at that hour. For individuals who started work at 7 a.m., their average sleep duration was 36 minutes shorter. Westernmost location promoted late wake-up times, particularly among the non-employed. While employed people were equally likely to be awake at 7:30 a.m. regardless of time zone location, non-employed people in the westernmost locations were 32% more likely to be asleep at that hour.

In addition to sleep times, health outcomes also were affected adversely. Individuals at the western boundary were 11% more likely to be overweight, a difference that reached statistical significance. There were additional nonsignificant trends toward other adverse health outcomes, such as diabetes, cardiovascular disease, and breast cancer. Overall, "self-reported health status" was 2% worse with late sunsets, but this did not reach statistical significance.

The authors used "back of the envelope calculations" to estimate economic consequences. They determined that circadian misalignment increases healthcare costs by $2 billion. Productivity losses induced by the extra hour of light in the evening were calculated to total 4.40 million days of work nationwide. There was an estimated 3% decrease in income among those living on the western side of a time zone. Total economic losses were estimated to be $2.35 billion (approximately $82 per capita). The authors calculated that a one-hour increase in daily sleep increases productivity to a greater extent than a one-year increase in education.

■ COMMENTARY

There are increasing data showing that sleep plays a key physiological role in the "glymphatic" system of the brain, a "dishwashing" mechanism that widens gap junctions and facilitates the removal of toxins. Multiple studies indicate that high-quality sleep, with increased periods of REM and slow-wave sleep, promotes clearance of substances such as amyloid and tau proteins. Although day-to-day

deficiencies in sleep duration promote cognitive loss (impairments in vigilance), more chronic cumulative sleep loss may have more permanent effects, including possibly Alzheimer's disease.

Seasonal differences in light exposure and sleep times may provide quasi-experimental data similar to this time zone investigation. Although daylight duration varies from 14 hours in summer to only eight hours in winter, humans sleep a fixed amount of time. This effect is strongly driven by latitude and perhaps would be less pronounced closer to the equator. It is possible that bears or other hibernating animals behave in a more physiologically favorable manner, being active in summer and sleeping for long periods during the winter, allowing for a cumulative clearance of central nervous system toxins.

As this study suggests, there would be benefits from more flexibility in work schedules. Although banks or public offices may follow a strict 9 a.m. to 5 p.m. day, retail stores maintain potentially more realistic hours, shifted to 10 a.m. to 6 p.m. or possibly an even later interval. While television schedules are modified to broadcast at appropriate times across Eastern to Pacific time zones, there is no such modification of show times within any given time zone. Modern TV practices, with streaming of content and "binge watching," would provide for more flexibility, but may have as-yet unrecognized adverse effects on sleep health. ■

CME QUESTIONS

1. **Fermentation of dietary fiber by the microbiome results in which of the following?**
   a. Glucose lowering
   b. Cholesterol lowering
   c. Production of small chain fatty acids
   d. Production of omega-3 fatty acids

2. **Which of the following is true regarding insect consumption?**
   a. Insects are a source of dietary protein, and the U.N. Food and Agricultural Organization considers edible insects to be of value and a food source.
   b. Insects have never been consumed by humans as a food source.
   c. Omnivore attitudes toward insect consumption are more negative than attitudes of vegetarians and non-vegan vegetarians.
   d. Cultural beliefs do not influence attitudes regarding entomophagy.

3. **Why are circadian rhythms important?**
   a. Circadian rhythms determine when we wake up and when we go to sleep.
   b. Circadian rhythms regulate vital metabolic and hormonal functions.
   c. Circadian rhythms are tightly linked to times of sunrise and sunset.
   d. Circadian rhythms do not affect brain health.

4. **Which statement is true regarding falls in the at-risk older Americans, based on the study by Li et al comparing Tai Ji Quan: Moving for Better Balance (TJQMBB) and multimodal exercise (MME)?**
   a. TJQMBB and MME were associated with equivalent reduced moderately and severely injurious falls in community-dwelling, at-risk older Americans.
   b. TJQMBB and MME were associated with equivalent reduced moderately injurious falls in community-dwelling, at-risk older Americans, and TJQMBB was associated with a greater reduction in severely injurious falls.
   c. TJQMBB and MME were associated with equivalent reduced moderately injurious falls in community-dwelling and nursing home at-risk older Americans.
   d. TJQMBB and MME were associated with reduced moderately injurious falls in community-dwelling and nursing home at-risk older Americans, and TJQMBB was associated with a greater reduction in severely injurious falls.

[IN FUTURE ISSUES]

Blueberries and Dementia

Magnesium: Review of the Latest Evidence

Mind-Body Exercise and Cognition

Organic Foods and Cancer