

*I enjoy the spring more than the autumn now. One does, I think, as one gets older.*

—Virginia Woolf



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# aging news

NEWSLETTER OF THE INSTITUTE ON AGING (IOA) | UNIVERSITY OF WISCONSIN-MADISON

## Americans Have Shorter Lives and Poorer Health

IOA Affiliate **Alberto Palloni** (Prof., Sociology, UW-Madison) is a member of the panel that wrote the National Research Council & Institute of Medicine report, *US Health in International Perspective: Shorter Lives, Poorer Health*, which has received widespread scientific and media attention. The report found that Americans have lower life expectancies and experience higher rates of disease & injury than people in 16 other high-income democracies, such as Canada, Japan, and many western European countries. This health disadvantage exists even though the U.S. spends more per person on health care than any other nation.



The findings applied to all age ranges from birth to age 75. Americans were less likely to survive to their first birthday or to age 5, teens had worse health, and adults had higher rates of chronic illnesses, as well as higher rates of death from car accidents and violence. Americans fared worse in nine key areas of health, including heart disease, chronic lung disease, obesity & diabetes, AIDS, disability, drug-related deaths, and injuries & homicides.

The panel concluded that many factors were responsible, including public policy

and underlying social values. Americans are more likely to engage in unhealthy behaviors, such as overeating and using firearms in acts of violence. U.S. communities are built around car use, which can discourage physical activity and increase obesity. Americans are more likely to find their health care inaccessible or unaffordable. The U.S. also has relatively high rates of poverty and lower rates of education, which are linked to poorer health. However, even advantaged individuals who had health insurance, college educations, higher incomes, and healthier behaviors, had poorer health than their equals in other rich nations.

The report calls for comprehensive outreach to alert the American public about the U.S. health disadvantage and stimulate a national discussion about what, as a society, we are willing to do about it. Recommended are intensified efforts to pursue already established national health objectives and more research to better understand the responsible factors and potential solutions. To view the complete report and an interactive chart that compares the U.S. to other countries, see: [www.nap.edu/catalog.php?record\\_id=13497](http://www.nap.edu/catalog.php?record_id=13497)

## Are Immigrants Healthier than US-born Americans?

Lower socioeconomic status (SES) is usually associated with worse health. However, in a contradiction known as the Hispanic Health Paradox, Hispanics in the U.S. have better than expected health, even though they have lower SES. IOA Affiliate **Alberto Palloni** (Prof., Sociology, UW-Madison) co-authored an article that found mixed reasons for the health paradox. Studies in the U.S. and Mexico compared five health outcomes in men over 50: high blood pressure, obesity, diabetes, smoking, and self-rated health. Once SES was controlled, Mexican immigrants showed better health than non-Hispanic whites in the U.S.

In some instances the Hispanic Health Paradox was a result of healthier Mexicans being more likely to move to the U.S. Immigrants had lower blood pressure and better self-rated health compared to Mexicans who didn't migrate. In other instances, unhealthy immigrants were more likely to leave. Those who returned to Mexico after being in the U.S. less than 15 years had higher blood pressure, more smoking, and poorer self-rated health, leaving behind healthier immigrants.

Analysis also showed that in some instances sociocultural practices resulted in Americans being in worse health than Mexicans. Whites in the U.S. were 77% more likely to have high blood pressure and 50% more likely to be obese than non-migrant Mexicans. Immigrants who were in the U.S. longer (15 or more years) and more likely to have adopted unhealthier American lifestyles, were 102% more likely to report diabetes and 79% more likely to report high blood pressure, compared to migrants who had been in the U.S. less than five years.

**Source:** Riosmena, F., Wong, R., & Palloni, A. (2012). *Migration selection, protection, and acculturation in health: A binational perspective on older adults*. *Demography*. Advance online publication. doi:10.1007/s13524-012-0178-9

## Colloquium Preview: Muscle Function and Risk of Falls

Osteoporosis is the age-related loss of *bone* mass, quality, and strength. It is connected to sarcopenia, the loss of *muscle* mass, quality, and strength. Together, they contribute to falls and bone fractures that can significantly reduce quality of life in older adults and result in loss of independence. Sarcopenia, however, is rarely diagnosed, in part because there is currently no agreed upon definition. IOA Affiliate **Bjoern Buehring** (Asst. Prof, Geriatrics, UW-Madison) recently presented a new "FRAX-like" approach to sarcopenia diagnosis at the 2012 annual meeting of the American Society for Bone and Mineral Research.

The proposed "FRAX-like" definition is similar to the FRAX (Fracture Risk Assessment Tool) used to predict osteoporosis-related fractures, and includes six risk factors: a measurement of low muscle mass (appendicular lean mass (ALM)/height<sup>2</sup>), a measure of the effects of obesity on muscle function (the leg fat/lean mass ratio), low bone mineral density (T-score), low grip strength, slow walking speed, and history of one or more falls in the last year. Presence of three or more risk factors indicates sarcopenia.

Ninety-seven adults aged 70 years or older underwent body composition measurements and muscle function tests. Prevalence of sarcopenia was 24% when based only on measurements of low muscle mass, 20% when the European consensus definition of low muscle mass with either low walking speed or low grip strength was used, and 10% based on the International consensus approach using low muscle mass and low gait speed. In contrast, prevalence was 40% when the "FRAX-like" definition was applied. This is similar to the percentage of older adults who actually fall every year (around 50% of those over 75), indicating that the "FRAX-like" approach may be a more sensitive predictor of future falls and fractures. Prof. Buehring will be presenting more of his sarcopenia research at the IOA Annual Colloquium this Fall (see opposite page).



*Unhealthy American lifestyles often include lower consumption of fruits, vegetables, and fiber in the diet, which can lead to weight gain.*

*However, changes in Mexican lifestyles are also resulting in weight increases that may erase any Hispanic health advantage for future immigrants.*



# 25<sup>th</sup> Annual Colloquium on Aging



## Keynote Physical Activity to Prevent Disability and Frailty in Older Adults

**Marco Pahor, MD**

*Professor and Chair, Dept. of Aging and Geriatric Research; Director, Institute on Aging; University of Florida*

As life expectancy continues to rise, maintaining independence has emerged as a major clinical and public health priority. Efficient and reliable locomotion, or the ability to move without assistance, is a fundamental feature of human functioning. Older people who lose mobility are less likely to remain in the community, have higher rates of morbidity, mortality, and hospitalizations and experience a poorer quality of life. Several studies show that regular physical activity improves physical performance, but definitive evidence showing that mobility disability can be prevented is lacking. The LIFE study, a Phase 3 randomized controlled trial, is being conducted to fill this gap.



## Hearing Loss & Aging: Over-looked & Under-treated

**Karen J. Cruickshanks, PhD**

*Professor, Depts. of Ophthalmology & Visual Sciences and Population Health Sciences, UW-Madison*

Hearing impairment is a common problem among older adults, yet often goes un-diagnosed & un-treated. Once thought to represent "normal" aging, recent studies are suggesting that the processes contributing to hearing loss may be slowed or prevented. Residents of Beaver Dam, Wisconsin, and their children, have been contributing to advances in hearing research for the past 20 years. This talk will highlight results from those studies, current ideas about what may cause hearing loss in aging, and the importance of good hearing for healthy aging.



## The Earliest Signs of Alzheimer's Disease

**Sterling C. Johnson, PhD**

*Professor, Geriatrics, UW-Madison*

By the time a diagnosis of dementia due to Alzheimer's Disease (AD) is given, the brain has already undergone substantial change. We need a way to identify AD prior to the onset of its disabling symptoms. This talk will focus on new brain imaging research that indicates the AD brain begins to undergo disease-related change many years prior to symptom onset. This pre-symptomatic time frame may be the optimal window for intervention, and this idea, as well as other implications of early identification, will be discussed.



## Assessing Muscle Function and Balance Problems at Home, in the Clinic, and in Research

**Bjoern Buehring, MD**

*Assistant Professor, Geriatrics, UW-Madison*

Decreased muscle function has a significant negative impact on mobility, quality of life, and mortality. This talk will focus on different aspects of neuro-muscular function (muscle strength, muscle power, endurance, balance) and give practical examples of when these become important in daily life. We will review how muscle function can be assessed at home and in the clinical setting. The presentation should enable the audience to assess their own or their patients' muscle function and mobility impairments. It will also provide an overview of what imaging and muscle function assessment tools are used in research and clinical trials. *(A preview of this talk is on the previous page.)*



## Health & Resource Fair

Resources to Improve Quality of Life:

*Social & Educational Programs  
Support for Independent Living  
Volunteer Opportunities  
Legal & Legislative Advocacy  
Retirement Communities  
Osteoporosis Screening  
Blood Pressure Testing  
Alzheimer's Treatment  
Swallowing Disorders  
Fitness & Nutrition  
Hospice Care*

## Poster Session

Meet with UW-Madison faculty, students & advanced trainees presenting their recent aging research.

## New Investigator Awards

Awarded to new UW-Madison researchers in recognition of outstanding achievement in biomedical, psychosocial, or clinical/applied aging research.

## Details

Sponsored by the Institute on Aging. CEUs will be offered. Registration will open in August when the registration brochure is mailed. If you are not on the mailing list, sign up via our website, or contact: (608) 262-1818 [aging@ssc.wisc.edu](mailto:aging@ssc.wisc.edu)

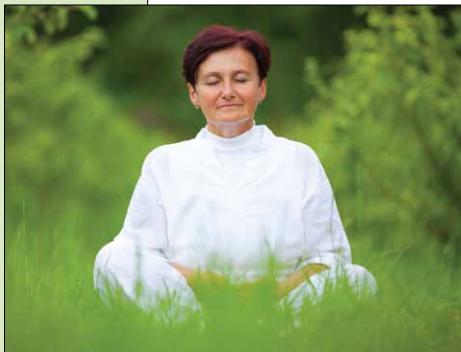
Upcoming details will be posted at:  
**[aging.wisc.edu](http://aging.wisc.edu)**

**SAVE THE DATE: TUES., SEPTEMBER 17, 2013**  
Registration opens in August

**FREE and OPEN to the PUBLIC**  
Held at Monona Terrace  
in Madison, WI

# affiliate news

For more information on the work of IOA Affiliated Faculty and Researchers at UW-Madison, see: [www.aging.wisc.edu/research/affilindex.php](http://www.aging.wisc.edu/research/affilindex.php)



## More on Meditation and the Prevention of Colds and Flu

IOA Affiliate **Bruce Barrett** (Assoc. Prof., Family Medicine,

UW-Madison) recently co-authored two articles about the MEPARI Study—Meditation or Exercise for Preventing Acute Respiratory Infection (ARI). Colds and flu were studied in 150 adults aged 50 and older, assigned to either 8 weeks of mindfulness meditation, exercise training, or to a control group who received neither. Initial results showed substantial reductions in ARI episodes and symptom severity among those in the exercise group, and even more benefits among those who received meditation training.

### Why Was Meditation Better Than Exercise?

ARI symptoms were analyzed in search of an explanation for the advantage of meditation over exercise. There were 22 measures of self-reported illness-related symptoms, in-

cluding physical issues, such as runny nose, sneezing, and body aches; and ratings of impact on function and quality of life, such as the ability to think clearly, climb stairs, and sleep well.

Results showed that in all but one of the 22 measures, subjects in the meditation group reported the lowest severity levels. When comparing physical symptoms vs. functional quality of life issues, the latter were responsible for the benefits from the meditation intervention. This may be because meditation emphasizes being aware of bodily sensations without being distressed by them, thus allowing subjects to stay functional, even in the face of cold or flu symptoms.

## Can Meditation Reduce Health Care Costs?

Another analysis showed that the meditation group had the least number of ARI-related lost work days and health care visits, and lowest medication expenses. Overall ARI costs were lowest for meditators, at \$65/subject, and increased to \$136 for the exercise group and \$214 for the control group. Extrapolating into the general population would represent a savings of \$28 billion a year for the meditation group and \$14 billion for the exercise group, thereby significantly reducing rising health care costs.



Class costs were not included in this estimate (\$450 per person), but over the long term, savings should still far outstrip the price of initial training. The challenge is knowing when and how training should be reinforced to continue its benefits.

**Sources:** *Rakel, D., Mundt, M., Ewers, T., Fortney, L., Zgierska, A., Gassman, M., & Barrett, B. (2013). Value associated with mindfulness meditation and moderate exercise intervention in acute respiratory infection: The MEPARI*

## AGING NEWS SPRING/SUMMER 2013

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## welcome new affiliates

### **Ying Ge** • Asst. Prof., Cell & Regenerative Biology

*Focus:* Understanding the molecular and cellular mechanisms underlying heart disease and aging via a systems approach combining chemistry, biology, and medicine.

### **Michelle E. Kimple** • Asst. Prof., Endocrinology

*Focus:* How the beta-cells of the pancreas respond to nutrient and hormonal stimulation in type 1 and type 2 diabetes.

### **Lauren M. Papp** • Assoc. Prof., Human Development & Family Studies

*Focus:* Marital conflict as it occurs among empty nest couples whose children have recently left the household.

Study. *Family Practice*. Advance online publication. doi:10.1093/fampra/cmt008 and Obasi, C. N., Brown, R., Ewers, T., Barlow, S., Gassman, M., Zgierska, A., . . . Barrett, B. (2012). Advantage of meditation over exercise in reducing cold and flu illness is related to improved function and quality of life. *Influenza*. Advance online publication. doi:10.1111/irv.12053



## Genetic Predictors of Depression

Depression is a widespread disorder that is reaching high rates in adults aged 80 years and older. It is influenced by environmental factors, such as experiencing difficult life events, but studies have shown that genetics also play a role in its development. Many of the genes associated with depression have been identified, but none taken alone adequately predict who will become depressed. IOA Affiliate **Craig Atwood** (Assoc. Prof., Geriatrics, UW-Madison) co-authored an article that explored an innovative statistical approach to determine whether interactions between genes would have more predictive value.

Prof. Atwood and his colleagues studied 4811 people from the Wisconsin Longitudinal Study, which follows Wisconsin high school graduates from the class of 1957. 713 subjects were identified as having major depression (a period of two or more weeks of feeling depressed and having at least three of the following symptoms: troubled sleep, tiredness, feeling bad upon waking, trouble concentrating, loss of weight, loss of interest in usually pleasurable pursuits, and thoughts of death).

Subjects provided saliva for genotyping, and interactions between 78 genetic variants, or single nucleotide polymorphisms (SNPs), were analyzed. Recursive partitioning (RP), a statistical method, was used to classify individuals into groups according to common genetic variations (SNPs) associated with the disease. This determined which combinations of SNPs were better candidates for predicting depression.

Further analysis (via logistic regression) was used to verify the significance of the genetic

interactions found through RP. The genes identified as most predictive of depression were associated with the neurotransmitter dopamine (which facilitates communication between nerves in the brain) and with neuroendocrine signaling pathways (which regulate hormone levels), both of which are known to impact depression.

Disease risk in humans is clearly affected by interactions between multiple factors. However, tools to analyze genetic interactions are not as well developed as the technology that allows identification of genetic differences among individuals. Recursive partitioning is underused in genetic studies, but these results demonstrate its utility in screening for genetic interactions that predict disease, which can then be confirmed by more traditional statistical approaches. Future studies could extend the use of RP to identify interactions between genes and non-genetic factors, such as environmental or sociobehavioral causes of depression.

**Source:** Roetker, N. S., Yonker, J. A., Lee, C., Chang, V., Basson, J. J., Roan, C. L., . . . Atwood, C. S. (2012). Multigene interactions and the prediction of depression in the Wisconsin Longitudinal Study. *BMJ Open*, 2(4), e000944. doi:10.1136/bmjopen-2012-000944



**People who report depressive symptoms often experience higher rates of physical illness and functional disability, and use more health care resources. In 2008, 16% of women and 11% of men over age 65 reported depressive symptoms.**

— *Older Americans 2012: Key Indicators of Well-being* at [agingstats.gov](http://agingstats.gov)



## affiliate grants & awards

IOA Affiliate **Corinne Engelman** (Asst. Prof., Population Health Sciences, UW-Madison) was chosen by the Charleston Conference on Alzheimer's Disease as one of 14 Outstanding Young Investigators in Alzheimer's Disease Research from across the county. Winners competed for funding, which Prof. Engelman and a colleague obtained, to conduct research on genetic variations that protect individuals with a strong family history of Alzheimer's from developing the disease.



IOA Affiliate **Luigi Puglielli** (Assoc. Prof., Geriatrics, UW-Madison) received two new grants related to Alzheimer's disease (AD) research. A VA Merit grant from the Department of Veterans Affairs will provide four years of support to test new strategies for the prevention of AD dementia. A grant from the Thome Memorial Foundation will provide two years of support to target the enzymes ATase1 and ATase2 for the prevention of neural damage associated with AD.

# new findings from MIDUS

Funded by the National Institute on Aging  
(P01 AG020166)

**MIDUS**  
Midlife in the United States

*MIDUS studies aging as a long-term journey involving multiple factors (psychological, social, biological). It began in 1995 with over 7000 participants, aged 25-74, and continues with follow-up studies at 10 year intervals. Over 450 publications have utilized MIDUS data. They are archived at: [midus.wisc.edu/findings](http://midus.wisc.edu/findings)*

*People who have been overweight all their lives are more likely to report being satisfied with themselves than those who gained weight in adulthood.*

## The Psychological Consequences of Being Overweight

The physical health consequences of obesity are well-known, but few studies have addressed its psychological effects, despite the social stigma against obese people. Studies show that obese people are often blamed for their weight due to personal flaws such as laziness and gluttony. Compared to thinner people, they receive lower wages and are more likely to report discrimination, teasing, and strained relationships with family. Understanding the psychological consequences of weight is important, given that a majority of U.S. adults (2/3<sup>rd</sup>s) are now overweight.

MIDUS researchers examined the effects of adult weight on five psychological outcomes: positive and negative mood (e.g., feeling cheerful vs. hopeless), perceived interpersonal discrimination (e.g., being treated with less courtesy or respect), self-acceptance (e.g., liking most parts of yourself), and self-satisfaction (i.e., how satisfied you are with yourself). They explored whether these outcomes were dependent upon being persistently overweight (e.g., since adolescence) or experiencing significant weight gain (e.g., in adulthood), comparing current weight vs. weight at age 21. They also analyzed whether effects differed between weight categories, measured by body mass index (BMI—based on height and weight measurements), in the following classifications: underweight, normal weight, overweight (BMI between 25 & 30), obese I (BMI between 30 & 35), and obese II/III (BMI of 35 or higher).

Results showed that obese II/III people fared worse on all five psychological



outcomes and were roughly half as likely as normal weight people to say they were “very satisfied” with themselves. Obese I people reported more frequent discrimination and were 20% less likely to say they were satisfied. However, those who were overweight all their lives were more likely to be “very satisfied” with themselves compared to overweight adults who were slender in youth. Regardless of younger weight, odds of being satisfied with one’s self still declined as weight increased.

Researchers also interviewed 40 currently or formerly overweight people in the greater New York area to learn how weight change could affect self-concept. These interviews illuminated many of the patterns detected in the MIDUS data. One person who was over 300 pounds, and had been obese since childhood, considered her weight to be an enduring part of herself. She was always aware of it and regularly reminded of it by family and strangers. By contrast, those who gained weight in adulthood struggled against thinking of themselves as overweight. They maintained the positive self-image of their slender selves, viewing their stigmatized status as temporary. They struggled with jarring reminders that they were overweight, such as seeing themselves in a mirror.

It was difficult for those who were overweight or obese in youth to maintain a positive self-concept. Even if they lost significant weight as adults, they had difficulty maintaining a sense of themselves as “thin” and did not enjoy the social confidence of people who were thin in youth. One person did not know how to respond when a stranger called him skinny. Another who lost 120 pounds was still shopping in the plus size clothes department. Many worried regularly about gaining weight, which is not unrealistic given studies showing that most dieters usually regain some lost pounds.



Future studies should explore how the above factors might affect attempts at weight loss. Those who have been overweight since childhood may view obesity as an enduring part of themselves and fail to try to lose weight, believing they can never be thin. Those who have gained weight later in life may not try to lose it if they are in denial about their real size, believing they will always be thin.

**Source:** Carr, D., & Jaffe, K. (2012). *The psychological consequences of weight change trajectories: Evidence from quantitative and qualitative data.* *Economics & Human Biology*, 10(4), 419-430. doi:10.1016/j.ehb.2012.04.007

## Anger & Obesity Contribute to Diabetes

Anger has been shown to contribute to heart disease. This MIDUS study explored whether anger also contributes to type 2 diabetes, which has similar risk factors as heart disease, and whether anger interacts with one of diabetes' most known risk factors, obesity.

Type 2 diabetes is normally contracted as one ages and involves a dysregulation of glucose (sugar) metabolism in the blood. The body's cells become resistant to insulin, the hormone that normally regulates blood glucose, which supplies the body's cells with energy. Several measurements of glucose metabolism were included: fasting glucose levels, insulin levels, insulin resistance, glycated hemoglobin (HbA1c—higher amounts of which indicate poorer control of blood glucose levels), and HOMA-IR (a measure of insulin resistance and how well the pancreatic cells that release insulin are working). Obesity was measured through body mass index (BMI) and size of waist-to-hip ratio (WHR).

Three types of anger were assessed. Anger-in measured how much people suppressed their anger (e.g., being irritated without others being aware). Anger-out measured aggressive verbal or physical expressions of anger (e.g., slamming doors, saying nasty things). Anger-control measured efforts to manage anger (e.g., calming down faster).

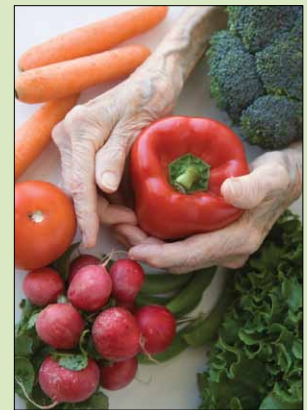


**Angry people may be more likely to develop diabetes, especially if they are also overweight.**

The analysis included 939 non-diabetics. Results showed that anger-in by itself was not significantly associated with any of the glucose control measurements, but the highest levels of insulin or HOMA-IR were evident among people who had *both* higher anger-in and higher BMI. Anger-in also increased the relationship between BMI and insulin and insulin resistance. Anger-out was by itself associated with insulin and HOMA-IR and also interacted with WHR to predict insulin and HOMA-IR. Anger-out also amplified the relationship between WHR and both insulin and insulin resistance. Anger-control was independently associated with glucose level, but only marginally interacted with WHR to predict insulin and HOMA-IR.

Results underscored the importance of considering psychological factors when analyzing risk for type 2 diabetes. Although obesity and a high waist-to-hip ratio are the most widely documented risk factors, they do not result in an inevitable progression to diabetes. Although more than 80% of people with type 2 diabetes are obese, most obese people never develop diabetes. This is the first study to link anger to glucose control, and results suggest that anger should be included among the established risk factors for diabetes, especially among people who are also vulnerable due to obesity.

**Source:** Tsenkova, V. K., Carr, D., Coe, C. L., & Ryff, C. D. (2012). *Anger, adiposity, and glucose control in nondiabetic adults: Findings from MIDUS II.* *Journal of Behavioral Medicine*. Advance online publication. doi:10.1007/s10865-012-9460-y

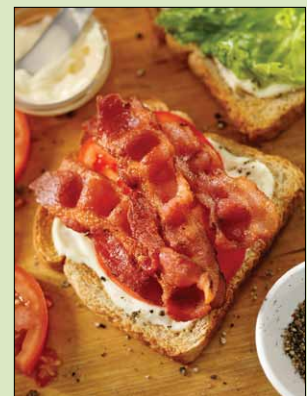


**Obesity (BMI ≥ 30) among people 65 and older increased from 22% in 1994 to 38% in 2010. The diet of older Americans was also found to be of poor quality in nine areas, including insufficient whole grains and a lack of dark green and orange vegetables.**

— Older Americans 2012: Key Indicators of Well-being at agingstats.gov

**Life expectancy would grow by leaps and bounds if green vegetables smelled as good as bacon.**

— Doug Larson



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**A**n archeologist is the best husband  
any woman can have: the older she  
gets, the more interested he is in her.

— Agatha Christie

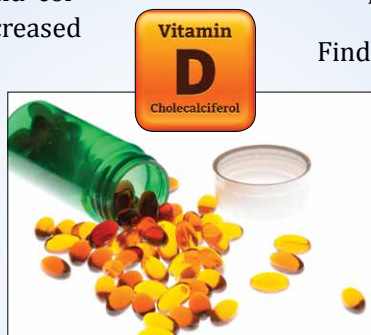
## Are Vitamin D Levels Affected by Genetic Risk Factors?

Vitamin D deficiency has been associated with many adverse health outcomes, such as osteoporosis, cancer, diabetes, and heart disease. However, increased time spent indoors, as well as avoidance of sun exposure due to fears of skin cancer, have led to a decrease in the amount of vitamin D being synthesized in the skin. Consequently, the Institute of Medicine (IOM) has recently raised the recommended dietary intake of vitamin D. Research by IOA Affiliates **Corinne Engelman** (Asst. Prof., Population Health Sciences), **Julie Mares** (Prof., Ophthalmology & Visual Sciences, both UW-Madison), and colleagues, asked whether some people require increased vitamin D intake due to differences in their metabolism of, or ability to transport, vitamin D, depending on their genetic makeup.

The study examined interactions between vitamin D in the diet, sun exposure (measured by month of blood draw), and genetic variants known to influence blood concentrations of vitamin D. These variants, or alleles, are different forms of the same gene that produce varied biological effects. Individuals with more copies of the alleles that put them at risk for inadequate blood levels of vitamin D may require higher vitamin D intake.

The new IOM recommended daily allowance for adults age 70 years or younger is 600 IU/day, and 800 IU/day for adults over 70. However, among 288 women aged 70 years or younger who were taking the recommended daily dose, only 66% of those with 3-4 risk alleles had achieved the recommended blood concentrations of vitamin D, compared with 91% of those with 0-1 risk alleles. Of the 102 women over age 70 who took the recommended dose, only 50% of those with 3-4 risk alleles had achieved an adequate vitamin D level, compared with 77% of those with 0-1 risk alleles.

Findings suggest that individuals with multiple genetic risk factors may need to consume higher amounts of vitamin D to achieve adequate concentrations in the blood. These results have implications for public health recommendations and clinical practice guidelines, suggesting that a “one size fits all” approach may not work for vitamin D.



**Source:** Engelman, C. D., Meyers, K. J., Iyengar, S. K., Liu, Z., Karki, C. K., Igo, R. P., . . . Mares, J. A., Millen, A. E. (2013). Vitamin D intake and season modify the effects of the GC and CYP2R1 genes on 25-hydroxyvitamin D concentrations. *The Journal of Nutrition*, 143(1), 17-26. doi:10.3945/jn.112.169482