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Biodynamics of Bone

Balance & Synergy of Key Nutrients

Calcium, Magnesium and Vitamin D

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I'm continually struck by the scale and scope of the biodynamics (speed of life) of the human body. Trillions of cells, each performing about 100 million metabolic events per second, every hour of every day, a controlled, contained and orchestrated "explosion" of activity that is life.

Our skeletal system has amazing biodynamic activities of its own. Bones are in a constant state of construction and destruction, never dormant, always changing. Osteoblasts, the constructors, work together with osteoclasts, the destructors, to tear down, renew, repair and replace the structural skeletal framework that supports our bodies. Interestingly, not all bone "moves" at the same speed. Trabecular bone, like that found in the hips, spine and wrist, is the softer and weaker interior bone tissue and renews at about 20% per year. Cortical bone, the stronger, harder exterior bone renews at about 4% each year. When all is working well and there is a perfect balance between construction and destruction, our bones remain healthy and strong throughout our lives.

Calcium has an obvious connection to bone health, density and strength that most people are aware of. But too little magnesium has also been implicated in osteoporosis. With more than 2/3 of Americans failing to achieve magnesium sufficiency researchers now believe its insufficiency is a major contributor to bone density loss. Additionally, some medical experts believe that we are suffering through a vitamin D deficiency "crisis." Sunlight is a primary source of vitamin D. But, because of the growing awareness of skin cancer risk from sunlight exposure, the trend towards decreasing exposure to sunlight is leaving many of us without optimal levels of vitamin D. As a result, problems caused by vitamin D deficiency, such as rickets, are on the rise in developed countries.

Calcium, magnesium and vitamin-D, working together in synergy, are critically important every day in order to keep the high intensity of biodynamics in our bones in balance. When not present in adequate amounts, bone destruction becomes faster than construction. As a result, bone density drops and osteoporosis occurs.

Calcium Reduces Risk of Death from CVD

Previous studies have suggested an association between calcium and lower blood pressure, and reduced risk of hypertension. Results from a recent study in Sweden report that intakes of calcium above the recommended daily levels could reduce the risk of death from heart disease by 25%.

23,366 Swedish men ages 45 to 79 participated in the population-based, prospective study. Researchers concluded: "…men with relatively high intakes of dietary calcium and magnesium showed that intake of calcium above that recommended daily may reduce all-cause mortality." According to the US National Institutes of Health (NIH), the upper tolerable limit for calcium is 2,500 mg, and excessive calcium intakes rarely occur from dietary or supplemental calcium intakes.

Kaluza J, et al. Dietary Calcium and Magnesium Intake and Mortality: A Prospective Study of Men. Am J Epidemiol. 2010 Feb 19. [Epub ahead of print]

Magnesium Reducing Risk of Colon Cancer?

Magnesium has been associated with more than 300 biochemical reactions in the body and research continues to validate the importance of supplementation with this important mineral. In an observational study from Japan, researchers found that intakes of at least 327 mg/day were linked to a 52% decrease in colon cancer risk in males, compared to intakes less than 238mg/day. 87,117 people with an average age of 57 were followed for 8 years in this study.

Dietary surveys show that a large portion of adults do not meet the RDA for magnesium (320 mg/day for women, and 420 mg/day for men). Food sources of magnesium include green, leafy vegetables, meats, starches, grains and nuts, and milk.

Although it is the most curable cancer if diagnosis is made early, colorectal cancer continues to be 9% of new cancer cases every year worldwide. Not surprisingly, the highest rates of incidence are in the developed world, while Asia and Africa have the lowest incident rates.

Ma E, et al. High Dietary Intake of Magnesium May Decrease Risk of Colorectal Cancer in Japanese Men. J Nutr. 2010 Feb 17; 140:779-85.

Magnesium Supplements and Lung Health

According to statistics from the European Federation of Allergy and Airway Diseases Patients Association (EFA), 30 million Europeans suffer from asthma. Epidemiological studies validate the importance of magnesium for asthmatic patients, but less than half of adults in the US get the recommended levels.

A recent study published in the Journal of Asthma looked at the role of magnesium supplements in lung function. The participants were 55 mild-to-moderate asthmatics between 21 and 55 years of age, and were randomly assigned to receive 340 mg of magnesium per day, or a placebo for 6.5 months. The results of this randomized placebo-controlled, double-blind trial found a 6% improvement in lung function, measured as the peak expiratory flow rate (PEFR) in the magnesium group, as well as improvements in the bronchial response to methacholine (a chemical that causes the lungs to constrict). The researchers postulate that the magnesium may affect properties of the cell membrane and thus improve the ability of the lungs to expand. Magnesium also has anti-inflammatory properties, which could help control asthma, too.

Kazaks AG, et al. Effect of oral magnesium supplementation on measures of airway resistance and subjective assessment of asthma control and quality of life in men and women with mild to moderate asthma: a randomized placebo controlled trial. J Asthma. 2010 Feb;47(1):83-92.

Vitamin D Supports Cardiometabolic Health

For the first time, researchers from the University of Warwick conducted a meta-analysis of 28 studies on nearly 100,000 participants to review the association between vitamin D and cardiometabolic disorders such as CVD, diabetes, and metabolic syndrome. This adds to the growing evidence substantiating the call from scientists all over the world to increase daily intakes of vitamin D, because of all the benefits associated with this important nutrient. They found that those with the highest blood levels of vitamin D had a 33% reduced rate of CVD, a 55% reduction in the risk of type-2 diabetes, and a 51% reduced risk of metabolic syndrome compared to those with the lowest blood levels of vitamin D.

Researchers concluded that "Targeting vitamin D deficiency in adult populations could potentially slow the current epidemics of cardiometabolic disorders." The mechanism of action is still not fully understood, but previous studies have postulated the role of vitamin D in enhancing the production of a protein which reduces the build-up of calcium in the arteries, and thusly, arterial hardening. Anti-inflammatory action and the rennin-angiotensin system have been proposed as well.

Parker J, et al. Levels of vitamin D and cardiometabolic disorders: Systematic review and meta-analysis. Maturitas. 2010 Mar; 65(3): 225-36.

Vitamin D Deficiencies Linked to Weaker Muscles

Vitamin D deficiencies have been implicated in osteoporosis, muscle weakness, fractures, common cancers, autoimmune diseases, infectious diseases and cardiovascular diseases. Now a recent study has found that low blood levels of vitamin D may also be associated with increased levels of fat in muscle tissue, which can result in reduced muscle strength. This is the first study to demonstrate this link between vitamin D and fat accumulation in muscle tissue.

Participants of the study were 90 healthy, young women between the ages of 16 and 22. Researchers observed that 60% of the women had insufficient levels of vitamin D (defined as blood levels lower than 29 nanograms per mL) and had higher muscle fat levels than the women with normal vitamin D levels. 24% of the women were deemed vitamin D deficient (levels below 20 ng/mL). These results are particularly fascinating since all the women were healthy and lived in California, with adequate exposure to sunlight.

Lead researcher, Dr Kremer comments: "We are not sure what is causing vitamin D insufficiency in this group. High levels of vitamin D could help reduce body fat, or, fat tissues might absorb and retain vitamin D, so that people with more fat are likely to also be vitamin D deficient."

Gilsanz V, et al.Vitamin D Status and Its Relation to Muscle Mass and Muscle Fat in Young Women. Clin Endocrinol Metab. 2010 Feb 17. [Epub ahead of print]

Omega-3s in Psychosis

Numerous studies have demonstrated the association between omega-3s and cognitive health and behavior. A recent study is the first of its kind to evaluate the benefits of omega-3s in those at ultra-high risk of psychosis. The results of this 12 week, placebo-controlled study found that supplementation with fish oil rich in EPA and DHA reduced the risk of progression to full threshold psychosis by 22.6% compared to the placebo group.

Participants were 76 patients with an ultra-high risk of progression to psychosis (those whose risk of becoming psychotic is as high as 40% in a 12-month period, along with mild psychotic symptoms, transient psychosis, or a family history of psychotic disorders, in combination with a decrease in functioning), and were randomly assigned to receive placebo (coconut oil) or fish oil supplements containing 1.2g of omega-3s with 700mg EPA, and 480mg DHA.

Only 4.9% of the treatment group progressed to psychotic disorder versus the 27.5% of the placebo group. Researchers believe the effect of omega-3s may be attributed to changes in cell membranes and interactions with neurotransmitter systems in the brain.

"The present trial strongly suggests that omega-3 PUFAs may offer a viable prevention and treatment strategy with minimal associated risk in young people at ultra-high risk of psychosis..." commented researchers. Typical side effects associated with the use of anti-psychotic drugs include metabolic changes, sexual dysfunction, and weight gain, but omega-3s can potentially prevent or delay the onset of psychosis with little adverse effects.

Amminger GP, et al. Long-Chain -3 Fatty Acids for Indicated Prevention of Psychotic Disorders: A Randomized, Placebo-Controlled Trial. Arch Gen Psychiatry. 2010;67(2):146-154.

Omega-3 Improves Kidney Health in Diabetics

Findings from a new study conducted at the University of Hong Kong found that supplementation with omega-3s led to significant decreases in creatine levels in diabetics. High creatine levels indicate damage of nephron function in the kidney. The results of this double-blind, placebo-controlled study is confirmed by previous studies that have demonstrated the renoprotective benefits of omega-3s in diabetics. In Europe, an estimated 19 million people are affected by diabetes, and in the US there are almost 24 million people with diabetes, equal to 8% of the population.

Wong CY, et al. Fish-oil supplement has neutral effects on vascular and metabolic function but improves renal function in patients with Type 2 diabetes mellitus. Diabet Med. 2010 Jan;27(1):54-60.

DHA Improves Chemotherapy Outcomes

According to the American Cancer society, there are half a million deaths associated with breast cancer around the world. The incidence has increased by 30% over the last 25 years in the west, but death rates have declined as a result of improvements in detection and treatments.

Data from a phase II clinical trial suggests for the first time that dietary interventions with DHA has the potential to increase survival in metastatic breast cancer patients treated with chemotherapy. They found that a along with their anthracycline-based chemotherapy, a daily dose of 1.8g DHA produced no adverse effects, and improved overall survival of women to 34 months in those with the highest DHA levels in their blood.

Bougnoux P, et al. Improving outcome of chemotherapy of metastatic breast cancer by docosahexaenoic acid: a phase II trial. Br J Cancer. 2009 Dec 15;101(12):1978-85.

Boosting Brain Function

There is growing evidence supporting the role of the omega-3 DHA and cognitive function, especially in children. A new study published in the American Journal of Clinical Nutrition evaluated 33 healthy boys between 8-10 years old and randomly assigned them to receive one of two doses of DHA (400 or 1200mg/day) or placebo for 8 weeks.

For the first time ever, scientists from the University of Cincinnati used functional magnetic resonance imaging (fMRI) to measure the effect of DHA supplementation on functional activity in cortical attention networks. The results showed that the DHA levels in the membrane of red blood cells increased by 47% and 70% respectively for the low and high dose DHA group, while dropping 11% in the placebo group.

There were significant increases in the activation of the dorsolateral prefrontal cortex part of the brain in the DHA groups, the part of the brain associated with working memory. The researchers commented: "These findings suggest that this imaging paradigm could be useful for elucidating neurobiological mechanisms underlying deficits in cortical activity in psychiatric disorders associated with DHA deficiencies, including ADHD and major depression."

McNamara RK, et al. Docosahexaenoic acid supplementation increases prefrontal cortex activation during sustained attention in healthy boys: a placebo-controlled, dose-ranging, functional magnetic resonance imaging study. Am J Clin Nutr. 2010 Apr;91(4):1060-7. Epub 2010 Feb 3.

Benefits of DHA for Middle-Aged

Numerous studies have reported on the potential brain boosting benefits of omega-3s, but a recent study investigated the role of DHA specifically in improving mental function in middle aged people. The cross-sectional study revealed that DHA can be attributed to brain health throughout life.

Researchers commented that "Higher DHA was related to better performance on tests of nonverbal reasoning and mental flexibility, working memory, and vocabulary. In addition, the increased levels of DHA are attributed to mental function improvements in a "generally linear" relationship.

Muldoon MF, et al. Serum Phospholipid Docosahexaenonic Acid Is Associated with Cognitive Functioning during Middle Adulthood. J Nutr. 2010 Apr;140(4):848-53. Epub 2010 Feb 24.

Antioxidants and Diabetes?

According to the World Health Organization (WHO), approximately 166 million people have diabetes mellitus worldwide, and this is expected to double by 2025 as a result of population growth, aging, unhealthy diets, obesity, and the sedentary lifestyle.

A new study looks to evaluate the role of dietary antioxidants in improved glycemic biomarkers in healthy adults, as well as diabetic patients, possibly determining if a diet high in antioxidants could prevent the development of diabetes. Previous studies postulated the mechanism of oxidative stress in diabetes to be linked to the increased free-radical production and the susceptibility of pancreatic cells to reactive oxygen species due to their low free-radical quenching enzymes.

Researchers believe that the oxidative stress damages mitochondria which in turn induces apoptosis of pancreatic beta cells and can result in reduced insulin activity and deregulate glucose levels. They also report that oxidative stress and inflammatory action are interrelated.

The results of their cross-sectional study do confirm previous data that higher total dietary antioxidant intake is correlated with lower levels of Glycemic indices in healthy individuals as well as pre-diabetic and diabetic ones.

Psaltopoulou T, et al. Dietary antioxidant capacity is inversely associated with diabetes biomarkers: The ATTICA study. Nutr Metab Cardiovasc Dis. 2010 Feb 18.

Carotenoids in Breast Health

Each year, over 1 million women worldwide are diagnosed with breast cancer, the highest incidence rates in the US and Netherlands. The most common type of tumors are the hormone-sensitive estrogen-receptor positive and the progesterone-receptor positive cases. Researchers from Sweden found that increased dietary intakes of alpha- and beta-carotene could reduce the risk of hormone-sensitive breast cancer among female smokers by 60%.

The study followed 36,664 women for almost a decade. The researchers suggest that the effect of alpha- and beta-carotene in breast cancer protection can be attributed to their antioxidant properties. This protective effect could be more "pronounced" among smokers because tobacco induces oxidative stress.

Larsson SC, et al. Dietary carotenoids and risk of hormone receptor-defined breast cancer in a prospective cohort of Swedish women. Eur J Cancer. 2010 Jan 27. [Epub ahead of print]

Flavonols and Stroke Risk

Strokes are the leading cause of disability and the third leading cause of death in Europe and the US. For the first time, researchers evaluated flavonols intake and its association with stroke incidence. The meta-analysis of prospective cohort studies used data from 111,067 people who were free of CVD or stroke at the start of their respective studies, with follow-up ranging from 6 to 28 years.

The researchers observed that those with high intakes of flavonols, particularly from tea in the Dutch population and from tea, onions, apples, and broccoli in the US studies, had a 20% reduction in stroke risk.

Hollman PC, et al. Dietary flavonol intake may lower stroke risk in men and women. J Nutr. 2010 Mar;140(3):600-4.

The Role of Vitamin A in Energy Production

Findings published in the FASEB Journal suggest that vitamin A (retinol) plays roles in the synthesis of ATP in mitochondria, which could explain why energy production is reduced by 30% when vitamin A is deficient in the cell. The researchers from the Institute for Cancer research found that when vitamin A is adequate, glycolysis and pyruvate production are the preferred energy sources. When cells are deprived of retinol, the body turns to fat oxidation for energy, but will also decrease their ATP production and respiration. This effect on ATP synthesis was reversed when retinol levels were restored. Researchers comment, "It is also predictable that chronic deviations of vitamin A transport will lead to metabolic disease."

Acin-Perez R, et al. Control of oxidative phosphorylation by vitamin A illuminates fundamental role in mitochondrial energy homeostasis. FASEB Journal. 2010 Mar; 24:627-36.

Gut Microflora Different in Diabetics

A breakthrough paper published in *Nature* in December 2006 reported that the gut microflora of obese and lean people differed, and when obese people lost weight, the profile reverted back to that observed in the leaner population, suggesting a relationship between the two.

New research from the University of Copenhagen now seeks to evaluate the relationship between the intestinal microbiota in people with and people without type-2 diabetes. Although it's too early to consider probiotics/prebiotics in diabetes prevention or management, this new research opens up a potential use in the future. Results of the trial showed significant differences in the microflora in those with type-2 diabetes. There was a reduced population of Firmicutes and increased proportion of Bacteroidetes and Proteobacteria. There was a positive correlation found between the ratio of Bacteriodetes to Firmicutes and reduced glucose tolerance. "The results of this study indicate that type-2 diabetes in humans is associated with compositional changes in intestinal microbiota…The level of glucose tolerance should be considered when linking microbiota with metabolic disease…"researchers concluded.

Larsen N, et al. Gut microbiota in human adults with type 2 diabetes differs from non-diabetic adults. PLoS One. 2010 Feb 5;5(2):e9085.

Probiotics for Mom

Gestational diabetes has the potential to cause a woman to subsequently develop type-2 diabetes, as well as put her offspring at an increased risk of childhood obesity and diabetes.

A recent study found that probiotic supplements could reduce the frequency of gestational diabetes by 20%, as well as confer benefits for the baby. 256 women in their first trimester of pregnancy participated in the study.

They were randomly assigned to a control group, or a group that received dietary counseling by a nutritionist. Those in the latter group were further randomized to receive probiotic supplements or a placebo. After 24 months, gestational diabetes was reduced in the probiotic group. In the few women affected by gestational diabetes, the dietary intervention diminished the risk of larger birth size infants.

Researchers concluded that, "The results of the present study show that probiotic-supplemented perinatal dietary counseling could be a safe and cost-effective tool in addressing the metabolic epidemic."

Luoto R, et al. Impact of maternal probiotic-supplemented dietary counseling on pregnancy outcome and prenatal and postnatal growth: a double-blind, placebo-controlled study. Br J Nutr. 2010 Feb 4:1-8. [Epub ahead of print]

Folate and Pancreatic Health

A new study supported by the US National Institutes of Health reported a 50% reduction in the risk of pancreatic cancer in women with folate intakes of 253.3 mcg/day compared to those with intakes below 179.1 mcg/day. The participants were between 55 and 74 years of age. These results add to the growing body of evidence for the anti-cancer potential of folate through its roles in DNA methylation, synthesis and repair.

Oaks BM, et al. Folate intake, post-folic acid grain fortification, and pancreatic cancer risk in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial. Am J Clin Nutr. 2010 Feb;91(2):449-55.

Soy: Reducing Diabetes Risk?

Researchers from the International Medical Center of Japan conducted a prospective study to examine the association of isoflavone intakes and type-2 diabetes. Using a 147-food frequency questionnaire, they asses dietary intakes of soy products and isoflavones.

They found that the risk of type-2 diabetes was 40-50% lower in overweight women who consumed 118 g/day of soy compared to the overweight women who consumed less than 43 g/day. Because of the study design, the results do not establish causality, but provide interesting observations into these potential benefits of soy. The mechanism of action is still unclear, but researchers postulate that the estrogen-like effect of isoflavones (estrogens have been reported to affect genes involved in insulin sensitivity and glucose uptake), or the improved insulin resistance of soy protein as potential mechanisms.

Nanri A, et al. Soy product and isoflavone intakes are associated with a lower risk of type 2 diabetes in overweight Japanese women. J Nutr. 2010 Mar;140(3):580-6.