Nutrition in Diabetes Prevention

An array of common dietary supplements and nutritional interventions has been examined in recent research, in efforts to treat pre-diabetes.

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Type 2 diabetes mellitus is classified by insulin resistance and pancreatic beta-cell dysfunction, which, subsequently, leads to increased blood glucose levels, also referred to as hyperglycemia. Individuals with pre-diabetes are characterized by having impaired glucose tolerance and/or impaired fasting glucose.[1] The blood glucose levels of the pre-diabetic, however, do not increase as dramatically as those with type II diabetes and may stave off full-blown diabetes for years. The high-risk state of pre-diabetic individuals for developing diabetes may be significantly reduced by lifestyle modification.[2]

Although the development of diabetes/pre-diabetes has a strong genetic influence, obesity is a significant contributing factor to decreasing insulin sensitivity.[3] Thus, the management of Type II diabetes and pre-diabetes typically incorporates diet modification and exercise in conjunction with a pharmaceutical regimen.[4] Obesity is also a key factor in the development of metabolic syndrome, in which insulin resistance is a primary characteristic.[5] Metabolic syndrome, encompasses a collaboration of physical and medical traits that pose as risk factors for cardiovascular disease and type 2 diabetes. Traits include: large waist circumference, high triglycerides, hypercholesterolemia, hypertension and fasting plasma glucose levels at 100mg/dL. Fasting plasma glucose levels for classification of pre-diabetes are at 100-125mg/dL.[6, 7]

Recently, the US Food and Drug Administration approved three new drug treatments to improve blood sugar control for type 2 diabetes[8]; however, a medication that specifically treats pre-diabetes has yet to be approved. The overall reluctance to comply with lifestyle alterations (i.e. reduce caloric intake, increase physical activity), by those with obesity-induced glucose metabolism abnormalities, has driven researchers to seek more intricate solutions, particularly in the realm of nutrition and nutraceuticals.[9]

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Nutritional Interventions

An array of common dietary supplements and nutritional interventions has been examined in recent research, in efforts to treat pre-diabetes. For example, omega 3 fatty acids are largely marketed with well-established health benefits with popular sources – fish oil and flaxseed. Flaxseed, in particular, is rich in omega 3 fatty acid, alpha-linoleic acid, and has shown greater efficacy than fish oil with specific regard to improving insulin resistance.[10-14] Hutchins et al. (2013)[15] recently observed that the long-term, daily consumption of ground flaxseed (13 grams) enhanced insulin sensitivity among pre-diabetic obese men and women.

Green tea, one of the most widely consumed beverages, has been well-examined in scientific literature and renowned for its many health benefits.[16] Consistent intake of green tea and green tea extract, individually, have shown to significantly decrease body weight and enhance body composition, while providing antioxidant benefits among obese individuals with metabolic syndrome.[17] Improving the antioxidant capacity of obese individuals is of significant benefit. The accumulation of fat is strongly correlated with oxidative stress, with an increased production of reactive oxygen species (ROS) in adipose tissue.[18] In addition, ROS production resultant of the onset and development of glucose intolerance leads to pancreatic beta cell dysfunction.[19]

Green tea has also demonstrated its efficacy in improving insulin sensitivity in association with increased expression of glucose transporter IV (GLUT IV) in animal models.[20-22] Research utilizing pre-diabetic human subjects observed lowered hemoglobin A1c levels, indicating improved blood glucose control, when administered green tea extract for two months.[23] Epigallocatechin gallate (EGCG) is a contributing polyphenol of green tea that has shown to improve vasodilation by stimulating the production of nitric oxide in the endothelium.[24] Insulin resistance, in combination with obesity and metabolic syndrome, leads to discrepancies in endothelial function, hindering blood flow. Compromised vasodilation, in turn, increases susceptibility to cardiovascular complications. Thus, promoting blood flow is an effective combatant against insulin resistance. By the same token, improving insulin sensitivity goes hand-in-hand with diminishing endothelial dysfunction.[25]

Role for Carnitine

Insulin levels, highly influenced by the consumption of higher glycemic carbohydrates, have a direct impact on increas-

ing blood flow via the stimulation of nitric oxide production.[26] Subsequently, insulin resistance may hinder insulin-mediated vasodilation. Glycine propionyl-L-carnitine (GPLC) and propionyl-L-carnitine (PLC) are forms of the endogenous compound, L-carnitine, that have both demonstrated increases in nitric oxide synthesis, promoting insulin-mediated vasodilation, without the consumption of carbohydrate.[27, 28] Recent research has discovered the ability of PLC to improve the insulin-resistant state of obese mice while reversing endothelial dysfunction and decreases in nitric oxide production.[29] Utilizing healthy human subjects (with normal glucose tolerance/disposal), studies examining GPLC intake have demonstrated increases in nitric oxide synthesis.[30, 31] Dietary supplements that promote nitric oxide synthesis may provide insight to the treatment of pre-diabetes, warranting further research for supplements that enhance hemodynamics.

Mitigating Stress

Kalman et al. (2013)[32] recently examined the effects of consuming the leaf extracts of *E. guineensis* and *F. deltoidea* in pre-diabetic adults. *Elaies guineensis* is an oil palm plant native to the tropics with an alcohol extract rich in phenolic compounds.[33, 34] *E. guineensis* leaf extract has also demonstrated considerable in vitro antioxidant activity while also promoting vascular relaxation.[35] Furthermore, a recent study demonstrated the ability of *E. guineensis* leaf extract to significantly mitigate the oxidative stress and hyperglycemic responses in rats injected with streptozotocin (to dramatically increase fasting blood glucose levels), subsequently, preventing detrimental effects on the rat liver and kidney.[36]

Ficus deltoidea, native to southeast Asia and commonly consumed in the form of tea, has demonstrated antioxidant activity attributed by its polyphenols, flavanoids and tannins.[37] Furthermore, *F. deltoidea* has demonstrated enhanced insulin-mediated glucose uptake via insulin-mimetic or insulin-sensitizing mechanisms.[38, 39]

Kalman et al. (2013)[32] found both leaf extracts to improve markers of health for the pre-diabetic overweight and obese subjects of the study. *E. guineensis* intake significantly enhanced insulin sensitivity while decreasing insulin resistance and waist circumference. *F. deltoidea* treatment significantly decreased total and LDL cholesterol levels.

Positives for Dairy

Recent research has discovered a positive correlation between long-term dairy consumption and insulin sensitivity. Rideout et al. (2013)[40] found that daily (four servings of low fat milk and yogurt products) dairy intake resulted in decreased fasting plasma insulin and insulin resistance among overweight and obese adults. Additional research using overweight/obese subjects classified with metabolic syndrome found that long-term dairy consumption (3.5 servings per day) improved antioxidant capacity and inflammatory responses while eliciting favorable effects on body composition (i.e. decreased waist circumference and trunk fat).[41] It is important to note, however, that the consumption of high-fat dairy foods may contraindicate the prevention of type 2 diabetes.[42] Vitamin D, calcium, whey protein and its amino acid constituents are among the bioactive compounds of milk that may enhance insulin sensitivity.[43-45] In addition to optimizing body composition[46, 47] and antioxidant capacity[48, 49], a large body of supporting evidence suggests that whey protein consumption may be a key dietary strategy to preventing and treating type 2 diabetes.[50-53] Furthermore, whey protein intake has also demonstrated significant improvements in vascular function, blood pressure and inflammatory responses for obese/overweight individuals.[54, 55]

Special Diets

The overall distribution of macronutrient (i.e. fat, carbohydrates, protein) intake plays a significant role in the treatment of pre-diabetes and management of type 2 diabetes. Insulin resistance is associated with dietary practices that consistently incorporate foods (i.e. high glycemic carbohydrates) that elicit dramatic increases in blood glucose and insulin.[26, 56] High protein, low carbohydrate diets (with moderate fat intake) have been shown to attenuate hyperglycemia more effectively and safely than other macronutrient ratio manipulations.[57, 58] High protein, low carbohydrate diets have also demonstrated favorable effects on body composition and weight-loss success.[59-61] Furthermore, incorporating low-glycemic carbohydrates appears to effectively manage insulin resistance.[62]

More specifically, low glycemic carbohydrates that are rich in fiber and increasing overall fiber intake (i.e. fiber supplements) provide a greater advantage for improving insulin sensitivity.[63-65] Research also suggests health benefit from incorporating a moderate amount of monounsaturated fat into the diet for those who may be at risk for insulin resistance.[66] Based on the aforementioned, it may be of no surprise that the Mediterranean diet (rich in monounsaturated fat), consisting predominantly of non-refined carbohydrates, vegetables, fruits, olive oil, dairy, fish, chicken, olives and nuts – is associated with enhancement of insulin sensitivity, endothelial function and body compostion.[67-69] ♦

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Research: Infants' Food Linked to Type 1 Diabetes Risk

Infants who get their first solid food before 4 months of age and after 6 months may have a higher risk of developing Type 1 diabetes, University of Colorado researchers have found. The researchers, from the Colorado School of Public Health and the CU School of Medicine's Barbara Davis Center for Diabetes, also found that the risk goes down if the mother is still breast-feeding the baby when solid foods, particularly those containing wheat or barley, are introduced into the diet.

The results were unveiled in the Journal of the American Medical Association publication JAMA Pediatrics. "For children who are introduced to solid food before four months of age, the risk of developing Type 1 diabetes is almost two times higher than for children introduced to solid foods at 4 or 5 months of age," says Jill Norris, MPH, PhD, chair of the Department of Epidemiology for the public health school. The findings align with the guidelines of the American Academy of Pediatrics on when to begin solid foods. "The data suggest that parents should wait to introduce any solid foods until after the 4-month birthday," Norris, one of the authors of the study, says. "And when baby is ready, solid foods should be introduced by the 6-month birthday or soon after, preferably while the mother is still breast-feeding the baby, which may reduce the risk of Type 1 diabetes."

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