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Research Article

THE POTENTIAL OF NUTRIGENOMICS IN THE PREVENTION OF METABOLIC SYNDROME

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A R T I C L E I N F O

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A B S T R A C T

Nutrigenomics is the study of effects of nutrition, nourishment or lack of nutrition on the genetic expression and anatomical or physiological changes of a living entity. Nutrigenomics aims to look at the holistic effect of diet and lifestyle on genome and on our state of health. It covers the overview of nutrigenomics and how it is associated with the prevention of diseases. The four basic tenets of nutrigenomics are, i) Improper diets are risk factors for diseases ii) Dietary chemicals alter gene expressions and change genome structure iii) The degree to which diet influences the balance between healthy and disease states may depend on an individual's genetic makeup iv) Some diet regulated genes are likely to play a role in onset, incidence, progression, and severity of chronic diseases. Genes express themselves through proteins. But dietary protein influence gene in many ways. Enzymes are special proteins designed to influence gene expression. Some foods such as cauliflower, broccoli and Brussels and sprouts contain chemicals that instruct our gene to direct biosynthesis. In some individuals,their gene give unclear instructions for making an enzyme that metabolizes the amino acids. As a result, this amino acid causes brain damage. So, restriction of this amino acid through dietary intake will stop the damage if detected in early infancy.So, nutrigenomics plays a major role for prevention of healthproblems in humans.

INTRODUCTION

Nutritional genomics is a highly innovative and fast-growing field, linking genome research, plant biotechnology and molecular nutritional research. It covers nutrigenomics, which explores the effects of nutrients on the genome, proteome and metabolome, as well as nutrigenetics, the major goal is to elucidate the effect of genetic variation on the interaction between diet and disease.

Nutrigenomics and nutrigenetics are two fields derived from nutrition science and genetics. Nutrigenomics looks at the interplay between our dietary and lifestyle behavior and how that interacts with our genome in terms of regulating genes that are important in the control of metabolism.nutrigenomics as the identification of genes that are involved in physiological responses to diet and the genes in which small changes, called polymorphisms, may have significant nutritional consequences.

Nutrigenomics includes known interactions between food and inherited genes, called 'inborn errors of metabolism,' that have long been treated by manipulating the diet:

- Phenylketonuria (PKU) is caused by a change (mutation) in a single gene. Affected individuals must avoid food containing the amino acid phenylalanine.
- Many Asians have a defective aldehyde dehydrogenase enzyme, which is involved in ethanol metabolism. Alcohol consumption has unpleasant effects on these individuals.
- Galactosemia-caused by an inherited defect in one of three enzymes involved in the metabolism of the sugar galactose-is controlled with a milk-free diet, since galactose is a metabolite or breakdown product of lactose or milk sugar.
- The majority of adults in the world are lactose intolerant, meaning that they cannot digest milk products, because the gene encoding lactase, the enzyme that breaks down lactose, is normally 'turned off after weaning. However some 10,000-12,000 years ago a polymorphism in a single DNA nucleotide appeared among northern Europeans. This single nucleotide polymorphism-a SNP-resulted in the continued expression of the lactase gene into adulthood. This was advantageous because people with this SNP could utilize nutritionally rich dairy products in regions with short growing seasons.

With the revolution in molecular genetics in the late twentieth century, scientists set out to identify other genes that interact with dietary components.

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97% of the genes known to be associated with human diseases result in *monogenic diseases*, i.e. a mutation in one gene is sufficient to cause the disease. Modifying the dietary intake can prevent some monogenic diseases. One example is phenylketonuria, a genetic disease characterized by a defective phenylalanine hydroxylase enzyme, which is normally responsible for the metabolism of phenylalanine to tyrosine. This results in the accumulation of phenylalanine and its breakdown products in the blood and the decrease in tyrosine, which increases the risk of neurological damage and mental retardation. Phenylalanine-restricted tyrosine-supplemented diets are a means to nutritionally treat this monogenic disease.[1]

In contrast, many common diseases, such as obesity, cancer, diabetes, and cardiovascular diseases, are *polygenic diseases*, i.e. they arise from the dysfunction in a cascade of genes, and not from a single mutated gene. Dietary intervention to prevent the onset of such diseases is a complex and ambitious goal.

Recently, it was discovered that the health effects of food compounds are related mostly to specific interactions on molecular level, i.e. dietary constituents participate in the regulation of gene expression by modulating the activity of transcriptionfactors, or through the secretion of hormones that in turn interfere with a transcription factor.

From this the "science of nutrigenomics" has emerged and it is now clear that certain dietary nutrients have the ability to interact with the human genome regulating gene function in positive and negative ways. Most importantly, the identification of specific nutrient chemicals that regulate genes is rapidly unfolding and the use of naturally occurring nutrient chemicals as pharmacological agents is becoming a reality. Finally, the development of new and innovative nutritional products for wellness and disease prevention.

Nutrigenomic diseases

Diseases and conditions that are known to have genetic and/or nutritional components are candidates for nutrigenomic studies to determine whether dietary intervention can affect the outcome. Differences in genetic makeup or genotype are factors in:

- gastrointestinal cancers
- other gastrointestinal conditions or digestive diseases
- inflammatory diseases
- osteoporosis.

Nutrient imbalances are factors in

- aging
- alcoholism/substance abuse
- behavioral disorders
- cancer
- cardiovascular disease (CVD)
- chronic fatigue
- deafness
- diabetes
- immune disorders
- macular degeneration
- multiple sclerosis
- neurological disorders
- osteoporosis
- Parkinson’s disease
- stroke.

Diseases that are known to involve interactions between multiple genetic and environmental factors such as diet include:

- many cancers
- diabetes
- heart disease
- obesity
- some psychiatric disorders.

Inherited mutations in genes can increase one’s susceptibility for cancer. The risk of developing cancer can be markedly increased if there is a gene-diet interaction. Studies of twins show that the likelihood of identical twins developing the same cancer is less than 10%, indicating that the environment plays an important role in cancer susceptibility. There are various examples of the effects of diet on cancer risk:

- High consumption of red meat has been shown to increase the risk of colorectal cancer.
- The incidence of colon cancer among Japanese increased dramatically after the 1960s as the Japanese diet became westernized.
- Dietary fiber has a protective effect against bowel cancer.
- Some studies have shown a relationship between dietary fat and breast cancer

Among people with high blood pressure only about 15% have sodium-sensitive hypertension. For the other 85%, eliminating salt from the diet has no effect on their blood pressure. Nutrigenomics is addressing why some people can control their hypertension with diet, whereas others require drugs. Some types of genes are modified by taking imbalanced dietary habits.

Nutrigenomics risks include

- The knowledge of a disease susceptibility may cause high levels of anxiety and stress.
- Genetic testing raises privacy concerns-some companies already sell the results of their genetic profiling to other companies.
- Those with known genetic susceptibilities may be discriminated against in employment or health insurance.
- Physicians may not be qualified to interpret nutrigenomic reports and make appropriate decisions based on them.
- The demand for nutrigenomic evaluations may eventually overtax the healthcare system. As with any new technology, nutrigenomics also may pose as-yet-unrecognized risks.

The nutrigenomics industry remains unregulated. It is unclear whether any future regulation will treat nutrigenomics as medicine or as nutrition.

CONCLUSIONS

The science of nutrigenomics continues to generate much interest and activity with the expectation that many of the disparities in wellness can be prevented, but much remains to be done, and this science is still in its infancy. The promise of nutritional genomics in personalized medicine and health is based on an understanding of our nutritional needs, nutritional and health status, and our genotype. Nutrigenomics could have significant impacts on society - from medicine to agricultural and dietary practices to social and public policies - and its applications are likely to compare to those arising from the human genome project. Chronic diseases (and some types of cancer) may be preventable, or at least delayed, by balanced, sensible diets. Knowledge gained from comparing diet/gene interactions in different populations may provide information needed to address the larger problem of global malnutrition and disease.

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