Title:
A Conceptual Framework for Nutrigenomics and Type 2 Diabetes

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Abstract Summary:
Type 2 diabetes (T2DM) is a complex disease with genomic and environmental components. Personalized nutrition based on individual risk factors and nutrigenomic principles has great potential for reducing incidence of T2DM. The conceptual framework described herein provides a basis for research to identify and evaluate personalized nutrition interventions for T2DM.

Learning Activity:

LEARNING OBJECTIVES	EXPANDED CONTENT OUTLINE
Describe the genetic, epigenetic, and environmental/behavioral risk components of type 2 diabetes.	I. Genetic risk for T2DM (many genes implicated with small effect sizes; genome-wide association studies studies); II. Epigenetic risk for T2DM (abnormal regulation of genes--silencing or inappropriate expression--in response to presence of genetic/environmental/behavioral risk factors, in absence of changes to DNA sequence); III. Environmental/behavioral risk (imbalanced nutrient intake, lack of physical activity, smoking, alcohol consumption, chronic stress, circadian rhythm/sleep disturbances, medications, and exposure to endocrine disrupting chemicals)
Describe the role of nutrient intake in modulating risk for type 2 diabetes, via interactions with genetic, epigenetic and environmental disease components.	I. Nutrigenomics of T2DM. A. Longitudinal studies, associations between certain nutrients and risk for T2DM (Nutrients/foods associated with increased risk; nutrients/functional foods associated with decreased risk). B. Nutrigenomic studies characterizing gene-nutrient interactions (changes in expression of T2DM risk genes in response to intake of specific nutrients or foods; epigenetic regulatory changes; compensation for genetic risk factors).
Describe the nursing implications of nutrigenomic research.	Precision medicine initiatives (nurse participation in gene-based interventions; understanding/applying knowledge of genomic risk for disease). Patient education about interactions of genetics, epigenetics, and environment in risk for T2DM. Personalized dietary interventions based on the unique risk

	factors of individuals at high risk for developing T2DM.

Abstract Text:

Purpose

The purpose of this analysis is to define a conceptual framework for studying how gene-nutrient interactions influence risk for Type 2 Diabetes Mellitus (T2DM) in adults.

Background and Significance

T2DM is a preventable chronic disease which has reached epidemic proportions in the United States. Incidence has increased by nearly 700% during the last 55 years. Existing prevention modalities are not adequate to halt these escalating disease rates. Although both genomic and environmental risk factors contribute to this disease, most preventative measures address only environmental factors. Additional interventions are needed which also address the genomic components of T2DM risk.

Discussion

Risk for T2DM is attributable in roughly equal proportions to environmental and genomic factors. Environmental factors encompass a variety of health behaviors and exposures such as physical activity, nutritional intake, tobacco use and alcohol use. Genomic phenomena include both genetics (inherited alterations in DNA sequence) and epigenetics (external modifications of DNA which can activate or repress gene transcription). Epigenetic modifications are important processes in human development and may be inherited, as with genetic imprinting. These modifications may also occur throughout the lifespan of the individual, in response to environmental exposures. One type of environmental exposure capable of inducing epigenetic changes is nutritional intake. This includes macronutrients (carbohydrates, protein, fats) and their relative proportions in one's diet, as well as micronutrients (food components such as vitamins, minerals, and phytochemicals). These nutritional exposures may contribute to or protect against pre-T2DM phenotypes through epigenetic mechanisms.

Model

Genetic, environmental, and epigenetic risk factors may each contribute to development of pre-T2DM phenotypes. Pre-T2DM phenotypes—such as obesity, inflammation, insulin resistance, and glucose intolerance—can induce epigenetic changes that worsen and add to those phenotypes. An individual's genetic inheritance and environment can both result in abnormal regulation of T2DM risk genes, through epigenetic mechanisms. Genetic and environmental factors may also be protective against development of pre-T2DM phenotypes. Genetic protective factors may compensate for the presence of environmental risk factors, and may protect against epigenetic alterations of T2DM risk genes. Environmental protective factors, such as nutrigenomic interventions, may reverse epigenetic changes and alleviate pre-T2DM phenotypes; they may also protect against T2DM development by compensating for genetic risk factors.

Conclusions

T2DM is a complex disease with multiple genomic and environmental components. The conceptual framework and model described herein provide a basis for conducting nutrigenomic research, characterizing gene-nutrient interactions of T2DM functional foods, and evaluating the efficacy of personalized nutrition interventions for T2DM. Personalized nutrition based on individual risk factors and nutrigenomic principles is a therapy with great potential for reducing the incidence of T2DM.

Nursing Implications

With the current emphasis in healthcare on precision medicine, it is increasingly important for the nursing profession to understand and apply knowledge of genomic contributions to diseases such as T2DM and the associated symptoms. The identification and characterization of gene-nutrient interactions which modify risk for T2DM enables the development of precision medical and nutritional interventions for T2DM prevention and treatment.