A Conceptual Framework for Nutrigenomics and Type 2 Diabetes

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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

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.

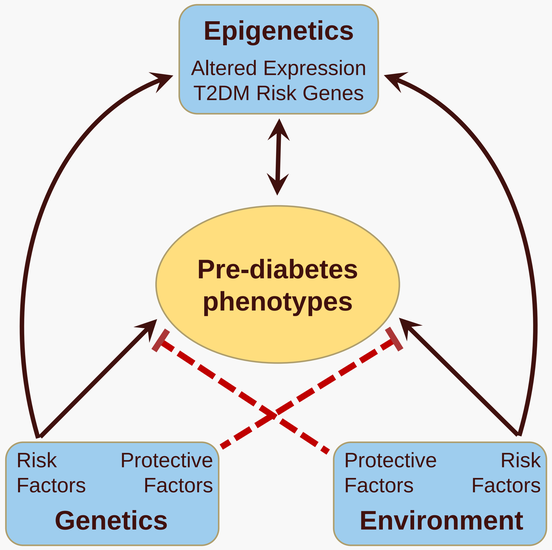
DISCUSSION

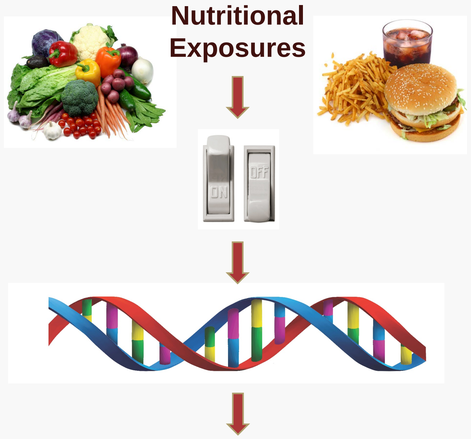
Risk for T2DM is attributable in roughly equal proportions to environmental and genomic factors. Environmental factors encompass a variety of health behaviors and exposures such as physical activity, nutritional intake, tobacco use and alcohol use. Genomic phenomena include both genetics (inherited alterations 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 either inherited or accumulated 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 epigenetic dysregulation of T2DM risk genes.
- Genetic and environmental factors may also be protective against development of pre-T2DM phenotypes, as shown by the red dashed lines.
- Nutrigenomic interventions are types of protective environmental exposures which may reverse epigenetic changes and alleviate pre-T2DM phenotypes. They may protect against T2DM development by compensating for genetic risk factors.





- **Altered expression of T2DM risk genes**
- **Increase or decrease in pre-T2DM phenotypes**

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 properties 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.

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.

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ACKNOWLEDGEMENTS:

The author has received funding support from the following:

- College of Nursing, University of Missouri-St. Louis (UMSL)
- Dr. Sue Dean-Baar, Dean of the College of Nursing, UMSL
- Nu Chi Chapter of Sigma Theta Tau International
- Hubert C. Moog Endowed Professorship
- UMSL Graduate School