Nutrigenomics and its role in P.C.O Nutritional management

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Topics
- What is Gene Modifier gene and nutrition
- What is nutrigenomics
- Genetic testing for personalized nutrition
- Position of the Academy of Nutrition and Dietetics
- Polycystic ovary syndrome and how it is presented
- Is it an easy process to reduce weight of PCO patients?
- What is the most suitable nutritional plans for these cases based on there Genetic analysis (Nutrigenomics)

WHY?
- Husband and wife of 40 years old
- Eat the exact 3 meals/day
- Non-starchy veggies
- Whole grain
- Exercise 5 hours/week together
- Wife: Cholesterol 180 mg/dL (normal)
- Husband: Cholesterol 220 mg/dL (normal)
- Why?
The answer is in our gene

A gene is the basic physical and functional unit of heredity.
- Genes are made up of DNA.
- Some genes act as instructions to make molecules called proteins.
- In humans, genes vary in size from a few hundred DNA bases to more than 2 million bases. The Human Genome Project estimated that humans have between 20,000 and 25,000 genes.
- Every person has two copies of each gene, one inherited from each parent. Most genes are the same in all people, but a small number of genes (less than 1 percent of the total) are slightly different between people. Alleles are forms of the same gene with small differences in their sequence of DNA bases. These small differences contribute to each person’s unique physical features.

What is Gene?
- Scientists keep track of genes by giving them unique names.
- Because gene names can be long, genes are also assigned symbols, which are short combinations of letters (and sometimes numbers) that represent an abbreviated version of the gene name.
- For example, a gene on chromosome 7 that has been associated with cystic fibrosis is called the cystic fibrosis transmembrane conductance regulator. Its symbol is CFTR.
• Genes consist of sequences of 4 nucleotides - (A, C, G and T)
• >1 possible nucleotide at a given position
• "C" replacing "A"
• Two copies of each gene are inherited
• Three possible genotypes (AA, AC, CC)

How do SNPs affect our risk of disease?

Single Nucleotide Polymorphisms:

SNPs & Modifier Genes:

• One gene, one disease — Not always the case
• Cystic Fibrosis.
• Phenylketonuria.
• Modifier genes
• Influence the expression of another gene.
• This makes translating the science to practice more complex.

Diet

SNP & Modifier Genes and Nutrition

SNP & Modifier Genes and Nutrition:

Role of "Modifier" Genes in Nutrition

Nutrition

Health Outcome

Genes

Genotype A
Genotype B
Genotype C
Increase
No Effect
Decrease

One Size does not fit all
What is Nutrigenomics?

Nutrigenomics:
The study of how individual genetic variation affects a person’s response to nutrients and impacts the risk of nutrition-related chronic diseases.

Tools to Personalize Medicine:

- Pharmacogenomics:
  - Uses an individual's genome to determine tailored drug prescription
- Pharmacy compounding:
  - Creating more specific targeted drug and supplement therapies
- Oncogenomics:
  - Application of genomics with cancer research and treatment
- Nutrigenomics:
  - Prevent chronic diseases by examining how the interaction between genes and diet can positively influence human health
Is Coffee Associated with CVD?
• Protective and increased risk depending on the genetic variation of the CYP1A2 variant.
• Personalized and tailored advice provided to patient to reduce risk.

**Nutrigenomics:**
FTO genotype, dietary protein intake, and body weight in a multiethnic population of young adults: a cross-sectional study

Background

Evidence in the fetal rat and epidemiologic data for FTO has been documented with supporting evidence that the association appears to be modified by diet. We investigated whether dietary patterns may modify associations between FTO genotype and body fat mass (BFM) and waist circumference (WC) in young adults aged 18-40 years from the cross-sectional Toronto Vitamin and Health Study (TVHS).

Methods

Genomic variants, dietary intakes, and body fat mass were collected and analyzed using a cross-sectional design. Dietary intake was assessed using a validated food frequency questionnaire. Physical activity was assessed using an accelerometer for 7 days, and body fat mass was measured using dual-energy X-ray absorptiometry. Data were analyzed using a linear regression model to test for the association between FTO genotype and percentage change in body fat mass and waist circumference adjusted for age, sex, and total energy intake. This association was assessed in individuals of European or South Asian ancestry. Among the FTO variants, TT+nA was associated with lower percentage change in body fat mass and waist circumference compared to AA in the European ancestry group. In the South Asian ancestry group, individuals with the TT+nA variant had lower percentage change in body fat mass and waist circumference compared to AA.

Results

The association between FTO genotype and body fat mass and waist circumference was significant in European ancestry individuals. Comparison with South Asian ancestry indicates that FTO genotype is associated with body fat mass and waist circumference in both ancestry groups. The association between FTO genotype and body fat mass and waist circumference was significant in European ancestry individuals. Comparison with South Asian ancestry indicates that FTO genotype is associated with body fat mass and waist circumference in both ancestry groups.
Nutrigenomics:

**Personalized Nutrition Expert**

**Perceptions of Genetic Testing for Personalized Nutrition: A Randomized Trial of DNA-Based Dietary Advice**

Chaun E. Mohamed, Sarah Davis, Alphonso D. Isacson
Department of Nutritional Sciences, University of Toronto, Toronto, Ont, Canada

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**Results**

Significant differences were observed when compared based on diet to control using one-way ANOVA. The LDL particle size and plasma levels of total cholesterol, LDL cholesterol (LDL-C), HDL-C, apo-B, apo-A-I, and triglycerides were determined. LDL particle size was significantly higher ($P < 0.04$) in subjects with the apoE 4/0 genotype compared with those with apoE 3/3 and apoE 3/4 in the basal state. LDL size was smaller ($P < 0.02$) after the CHO diet than after the MUFA or SFA diets. After the CHO diet, a significant increase in LDL particle size ($P < 0.005$) was noted with respect to the MUFA diet in apoE 4/0 subjects, whereas a significant decrease was observed in the apoE 3/3 individuals ($P < 0.04$). In conclusion, a Mediterranean diet, high in MUFA-fat increases LDL particle size compared with a CHO diet, and this effect is dependent on apoE genotype. J Nutr 134: 2571-2572, 2004.

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**Nutrigenomics:**

Which group do you feel would provide you with the best personalized nutrition advice?
Within our Scope as Dietitians?

- We do not need to become chefs in order to teach people how to cook healthful meals.
- We do not have to be geneticists in order to practice Nutrigenomics.
- We are THE nutrition experts and the most trusted source of evidence-based food and nutrition information, thus should be THE ONLY practitioners providing personalized nutrition advice.

Nutrigenomics

Position Statement

It is the position of the Academy of Nutrition and Dietetics that nutritional genomics provides insight into how diet and genotype interactions affect phenotype. The practical application of nutritional genomics for complex chronic disease is an emerging science and the use of nutrigenetic testing to provide dietary advice is not ready for routine dietetics practice. Registered dietitian nutritionists need basic competency in genetics as a foundation for understanding nutritional genomics; proficiency requires advanced knowledge and skills.
The Integriatve and Functional Medicine Nutrition Therapy (IFMNT) Radial

- IFMNT Radial was established as an integrated conceptual framework to assist in IFMNT practice.
- The circular architecture of the IFMNT Radial allows for the evaluation of complex interactions and interrelationships.
- The Radial depicts that food is a determining factor in health and disease and is a source of biological information that influences, and is influenced by, the five key areas.
- The five key areas are: lifestyle, systems (signs and symptoms), core imbalances, metabolic pathways, and biomarkers (i.e., Genomics and SNPs).
- Surrounding the Radial are precipitating factors that can affect the individual.

Nutrigenomics:

- Polycystic ovary syndrome is becoming very common among girls from ages 14 to 21 years old alongside women in their childbearing period. They usually presented with menstrual irregularities, overweight or obesity, insulin resistance (type 2 diabetes) and symptoms of virilization are characteristics of these cases.

What is the role of nutritionists in managing PCO:

- Anthropometric assessment and laboratory assessment
- Provide empathetic, supportive, encouraging approach
- Provide education on PCOS and insulin resistance
- Provide education and support on healthy diet, supplements, sleep, stress, and exercise.
- Assess symptom severity (including eating disorder behaviors)
- Assess medication and supplement compliance

Is it an easy process to reduce weight of PCO patients?

Challenges For Women with PCOS:

- Yo-yo dieters
- Insane cravings
- Increased hunger (Leptin and Ghrelin issue)
- Higher prevalence of obstructive sleep apnea
- Hypoglycemia common
- Dermatological concerns
- Higher prevalence of eating disorders
- Increased mood disorders
- Exposed to inaccurate nutrition advice
Medical Nutrition Therapy (MNT) Long-Term Goals:
• Reduce body weight if overweight
• Maintain weight loss after weight reduction
• Obtain knowledge and skills to support behavior changes
• Resolve metabolic syndrome
• Reduce risk factors for T2D and CVD
• Improve infertility

What is the most suitable nutritional plan for these cases?

Effects of Increased Protein-to-Carbohydrate Ratios
• Controlled, 6 mo. trial, 27 PCOS women
• High Protein (HP) (>40% protein, 30% fat) vs. Standard Protein (SP) (<15% pro, 30% fat); no caloric restriction
• Monthly dietary counseling
• Results: HP decreased weight (7.7 vs 3.3 kg), body fat loss (6.4 vs 2.1 kg), waist circumference, glucose.
• No difference in lipids, hormones.

DASH Diet For PCOS
• Randomized-controlled trial
• 48 women with PCOS, 8 weeks duration
• DASH & control diet consisted of 52% carbohydrates, 18% proteins, 30% total fats
• Results: DASH diet significantly reduced insulin, CRP levels, reductions in waist & hip circumference measurements
Low GI For PCOS
• Low glycemic index (GI) vs. Conventional Diet (CD)
  – 50% CHO, 23% protein, 27% fat
• 66 Overweight/obese women with PCOS, 12 months
• Results:
  – Low GI had better menstrual regularity (95% vs. 63% on CD), better insulin sensitivity
  – Those with high insulin levels had a 2-fold reduction in body fat (modest weight loss) vs. CD

Anti-Inflammatory/Mediterranean Diet For PCOS
• 100 overweight & obese PCOS Women, 12 weeks
• Reduced calorie, 5 small meals
• 25% proteins, 25% fat, and 50% carbohydrates
• Moderate to high fiber
• Emphasis on fish (2x/week), legumes, low-fat dairy
• Limited chicken, red meat, added sugars
• 5 cups of green tea daily

Results
• Mean weight loss 7.2%, WC ↓ 6.6%, BFP ↓ 9.2%, VFA ↓ 21.7%
• T Chol ↓ 8.9%, TG ↓ 18.02%, LDL ↓ 10.6%
• FBG ↓ 5.15%, BP ↓ 4.3/2.7 mmHg
• CRP ↓ 35%, SSA ↓ 38.25%
• 63% regain of menstrual cyclicity, 12% spontaneous pregnancy rate

Role of Nutrigenomics in personalized diet plans for P.C.O
Based on the previous data we need to understand more on the genetic variants and response of each patient to select the most suitable nutritional plans.

We will select either to have a high protein diet or to use the Mediterranean diet.

We will be able to determine physical activity intensity and duration based on the genetic analysis and variants.
Based on Genetic analysis we will be able to customize the nutritional plan as well as micronutrients and vitamins requirement for managing these cases.

Thank you