Is Genetic Testing for Personalized Nutrition Ready for Prime Time?

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What do the skeptics say?

Companies are trying to use your DNA and bacteria to give you personalized diet advice — here’s what the science says

In our never-ending quest to get healthy, there’s a constant, nagging hope that we’ll find a hidden key to fitness — some trick or piece of information that finally makes it easy to look and feel how we want.

That’s why bizarre diets take off and nutrition “breakthroughs”
Disease Risk Genes vs Metabolic/Modifier Genes
Why are genetic differences important for nutrition?

Nutrition

Genes

Genotype A
- Increase

Genotype B
- No Effect

Genotype C
- Decrease

Health Outcome

One size does not fit all
Coffee Intake and Risk of Myocardial Infarction

Coffee, CYP1A2 Genotype, and Risk of Myocardial Infarction

Marilyn C. Cornelis, BSc
Ahmed El-Sohemy, PhD
Edmond K. Kabagambe, PhD
Hannia Campos, PhD

*JAMA. 2006;295:1135-1141*
Coffee Intake and Risk of Myocardial Infarction

<table>
<thead>
<tr>
<th>CYP1A2 Genotype</th>
<th>&lt;1 cup/d</th>
<th>1 cup/d</th>
<th>2-3 cups/d</th>
<th>≥4 cups/d</th>
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<tr>
<td>Odds Ratio</td>
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<tr>
<td>AA</td>
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<td>AC + CC</td>
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* P<0.05

Cornelis et al., JAMA 295: 1135-41, 2006
CYP1A2 genotype modifies the association between coffee intake and the risk of hypertension
Paolo Palatini\textsuperscript{a}, Giulio Ceolotto\textsuperscript{a}, Fabio Ragazzo\textsuperscript{a}, Francesca Dorigatti\textsuperscript{a}, Francesca Saladini\textsuperscript{a}, Italia Papparella\textsuperscript{a}, Lucio Mos\textsuperscript{b}, Giuseppe Zanata\textsuperscript{c} and Massimo Santonastaso\textsuperscript{d}

Replication: Risk of Hypertension

- Abstainers
- 1-3 cups/day
- ≥4 cups/day

### CYP1A2 Genotype

- AA
- AC + CC

*P* < 0.05

Palatini *et al.*, J Hypertens 27: 1594-1601, 2009
Association of coffee consumption and CYP1A2 polymorphism with risk of impaired fasting glucose in hypertensive patients

Paolo Palatini · Elisabetta Benetti · Lucio Mos · Guido Garavelli · Adriano Mazzer · Susanna Cozzo · Claudio Fania · Edoardo Casiglia
A government panel said drinking coffee is harmless. Why that might be wrong.
A U.S. panel said coffee can be part of a healthy diet. That might be true only for half of us.
“There are spectacular metabolic differences in people, and to expect that coffee will have the same health effects on everyone is absurd,”

- Dr. Sander Greenland
  Professor Emeritus, Epidemiology
  UCLA
“Unfortunately, because genetic testing is expensive and rarely done, most people have little idea which gene variant they carry.”

- Panel Member
Coffee consumption and health: umbrella review of meta-analyses of multiple health outcomes

Robin Poole, Oliver J Kennedy, Paul Roderick, Jonathan A Fallowfield, Peter C Hayes, Julie Parkes

Three cups of coffee a day 'may have health benefits'

By Philippa Roxby
Health reporter, BBC News

23 November 2017 | Health
For Coffee Drinkers, the Buzz May Be in Your Genes

By ANAHAD O’CONNOR
JULY 12, 2016

Like most of my work, this article would not have been possible without coffee.
Moving towards Specific Nutrigenetic Recommendation Algorithms: Caffeine, Genetic Variation and Cardiovascular Risk

Raffaele De Caterina\textsuperscript{a} Ahmed El-Sohemy\textsuperscript{b}

\textsuperscript{a}Institute of Cardiology, ‘G. d’Annunzio’ University, Chieti, Italy; \textsuperscript{b}Department of Nutritional Sciences, University of Toronto, Toronto, Ont., Canada
DNA-Based Diet Advice Is Big Business With Little Scientific Support

Tech companies are selling expensive diets based on genetic and microbiome sequencing. But scientists say there are no shortcuts to healthy weight loss.
Sadly, we shouldn’t hold our breath. A 2015 meta-analysis that examined the available research on this category of startups found that “solid scientific evidence is currently lacking.” The science behind these startups is fundamentally flawed, says Aaron E. Carroll, a pediatrician, professor of pediatrics at Indiana University School of Medicine, and author of *The Bad Food Bible*. There’s no evidence that some people respond better to high-fat diets while others are more receptive to diets packed with protein or complex carbs. “It doesn’t exist,” he says. Even if it did, “there’s no evidence we could detect it” through DNA sequencing. Metabolic illnesses and disorders such as celiac disease or lactose intolerance aside, humans’ genes are very similar. We evolved to be able to eat the same foods.

When I mention this to Josh Anthony, Habit’s science advisor, he directs
Loss of fat mass (%) after 2 years of low or high protein diet by FTO genotype

Effects of a High-Protein/Low-Carbohydrate Diet versus a Standard Hypocaloric Diet on Weight and Cardiovascular Risk Factors: Role of a Genetic Variation in the rs9939609 FTO Gene Variant

Daniel Antonio de Luis   Rocío Aller   Olatz Izaola   David Primo
Silvia Urdiales   Enrique Romero

Personalized Dietary Advice

vs

Public Health Recommendations
Does genetic information influence behavior?

I have the gene, so I eat healthily.

I have the gene, so what can I do?
Does genetic information influence behavior?

A randomized trial of genetic information for personalized nutrition

Daiva E. Nielsen • Ahmed El-Sohemy

- DNA-based dietary advice resulted in:
  - greater understanding of recommendations
  - greater interest in learning more
  - greater motivation to change eating habits
Does genetic information influence behavior?

Disclosure of Genetic Information and Change in Dietary Intake: A Randomized Controlled Trial

Daiva E. Nielsen, Ahmed El-Sohemy*
Department of Nutritional Sciences, University of Toronto, 150 College St, Toronto, ON, M5S 3E2, Canada

- Greater compliance after 1 year.
An Intervention Study of Individual, apoE Genotype-Based Dietary and Physical-Activity Advice: Impact on Health Behavior

Hanna-Leena Hietaranta-Luoma\textsuperscript{a}  Raija Tahvonen\textsuperscript{b}  Terhi Iso-Touru\textsuperscript{b}  Hannu Puolijoki\textsuperscript{c}  Anu Hopia\textsuperscript{a}

*J Nutrigenet Nutrigenomics* 2014;7:161–174
Effect of an Internet-based, personalized nutrition randomized trial on dietary changes associated with the Mediterranean diet: the Food4Me Study


Can genetic-based advice help you lose weight? Findings from the Food4Me European randomized controlled trial


Replication: behavior change

TAKING ACTION
After receiving genomics results, 42% of 1,051 surveyed people reported positive changes in their health behavior. Only 1% of all respondents altered a prescription treatment without consulting a doctor.

Dietary patterns
72%

Exercise habits
61%

Supplements
17% with medical consultation 21% without medical consultation

Non-prescription drugs
10% with medical consultation 7% without medical consultation

Prescription drugs
11% with medical consultation 2% without medical consultation

*Many respondents reported more than one change, so percentages total more than 100%.

Source: Preliminary data from PGen Study, 2012–13

Diet and exercise changes following direct-to-consumer personal genomic testing

Daiva Elena Nielsen¹,²⁺, Deanna Alexis Carere³⁺, Catharine Wang⁴, J. Scott Roberts⁵, Robert C. Green¹,²,⁶,⁷*, for the PGen Study Group
What do the skeptics say?
Position of the Academy of Nutrition and Dietetics: Nutritional Genomics


Applying nutritional genomics in clinical practice through the use of genetic testing requires that registered dietitian nutritionists understand, interpret, and communicate complex test results in which the actual risk of developing a disease may not be known.
What the skeptics say...which is false

- Single SNPs are useless.
- People won’t change their behaviors.
- It’s the microbiome.
Host genetic variation impacts microbiome composition across human body sites

Ran Blekhman, Julia K. Goodrich, Katherine Huang, Qi Sun, Robert Bukowski, Jordana T. Bell, Timothy D. Spector, Alon Keinan, Ruth E. Ley, Dirk Gevers, Andrew G. Clark

Genetic Determinants of the Gut Microbiome in UK Twins

Julia K. Goodrich, Emily R. Davenport, Michelle Beaumont, Matthew A. Jackson, Rob Knight, Carole Ober, Tim D. Spector, Jordana T. Bell, Andrew G. Clark, and Ruth E. Ley

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http://dx.doi.org/10.1016/j.chom.2016.04.017
Association of host genome with intestinal microbial composition in a large healthy cohort

Williams Turpin1,2, Osvaldo Espin-Garcia3,4, Wei Xu4, Mark S Silverberg1-3, David Kevans1,2, Michelle I Smith1,3, David S Guttman5,6, Anne Griffiths7, Remo Panaccione8, Anthony Otley9, Lizhen Xu4,10, Konstantin Shestopaloff4, Gabriel Moreno-Hagelsieb11, GEM Project Research Consortium12, Andrew D Paterson4,10,13 & Kenneth Croitoru1,3

published online 3 October 2016
What the skeptics say...which is false

- Single SNPs are useless.
- People won’t change their behaviors.
- It’s the microbiome.
- We need to integrate all of the ‘omics’ technologies.
- Biomarkers are more important.
- We need more evidence. From RCTs.
- Results from genetic tests are too complex.
- Family history is more informative.
- Just follow recommendations for healthy eating.
Where are we today?

- We need to eat……today.
- We currently give dietary advice for healthy eating.
- Current recommendations are based on (old) science.
- How much more evidence do we need?
Is DNA-based Dietary Advice Ready for Prime Time?  Yes

- Scientific evidence is robust (for some markers)
- Independent of ethnic background
- Improved compliance (evidence from RCT)
- Information is actionable and “personalized”
- Increasing consumer awareness and demand
- Focus on wellness/prevention, not disease treatment
Acknowledgements

Marilyn Cornelis
Daiva Nielsen
Bénédicte Fontaine-Bisson
Dennis Wang
Karen Eny
Leah Cahill
Bibiana García-Bailo
Ilana Platt
Stephen Ozsungur
Joanne Brathwaite
Christine Asik
Cristina Cuda
Sara Mahdavi

Hyeon-Joo Lee
Susana Huang
Lindsay Stewart
Alejandra Navarro-Allende
Nanci Guest
Joseph Jamnik
Andre Dias
Laura Da Costa
Karina Fischer
Andrea Josse
Lilli Mauer
Erica Day-Tasevski
Ohood Alhabri

Hannia Campos
Alaa Badawi
Tom Wolever
David Jenkins
Christoph Borchers
Andrew Paterson
Guang Sun
Steven Narod
Paolo Palatini
Acknowledgements

Advanced Foods and Materials Network Centres of Excellence
Natural Sciences and Engineering Research Council
Canadian Institutes of Health Research
Canada Research Chairs
Nutrigenomix Inc.
Message from the Guest Editors

Dear Colleagues,

The integration of various ‘omics’ technologies into studies linking nutrition to human health and performance has greatly enhanced our understanding of the effects of specific nutrients, food bioactives and dietary patterns. These discoveries have helped us understand individual nutritional requirements, identify the presence of food preferences and intolerances, and establish specific dietary patterns that improve health and performance. This Special Issue of the *Journal of Personalized Medicine* aims to highlight the current state of the science and showcase some of the latest findings in the field of nutrigenomics. Studies include those that explore gene-diet interactions using basic science, clinical and population-based approaches. The scientific advances in the field of nutrigenomics and nutrigenetics will continue to pave the path towards personalized nutrition for optimal health and wellness.

Prof. Ahmed El-Sohemy
Prof. José M. Ordovás
Guest Editors