Personalized Nutrition vs. Dietary patterns: Are we ready to personalize diets?

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Disclosure Information

- I have no actual or potential conflicts of interest.
- I have served as a consultant for SNPitty the past two years.

General Dietary Recommendations

- Recommendations based on population-based research are a necessary starting point to establish dietary guidelines.

- Health Canada's 2015 Evidence Review Cycle concluded that the following diet-health associations, amongst others, are scientifically supported:

- *Sodium and increased risk of high blood pressure.*
- *Trans fatty acids and increased risk for cardiovascular disease.*
- *Dietary patterns – characterized by higher consumption of vegetables, fruits, whole grains, and lower consumption of red and processed meat, sugar-sweetened beverages – and positive cardiovascular disease outcomes.*

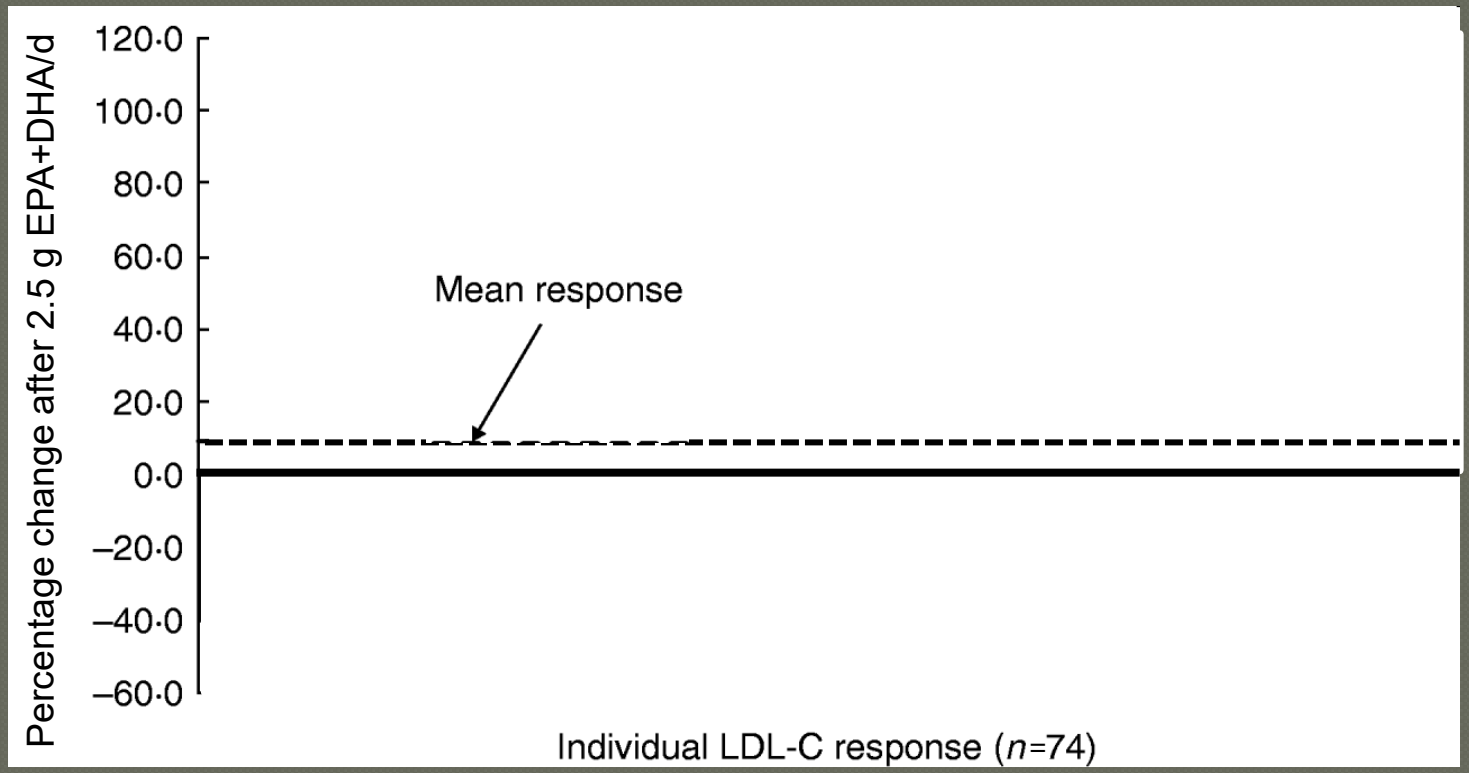
Nutrient → **Health Outcome**

Population vs. Individuals

"Current dietary recommendations are based on population averages and often do not take into account individual variability in response to nutritional components. Although successful in reducing the population-level chronic disease burden, dietary guidelines based on population averages may not be best suited for a given individual." *- DD Wang & FB Hu, Lancet Diabetes Endocrinol 2018*

Example 1: Individual Responses

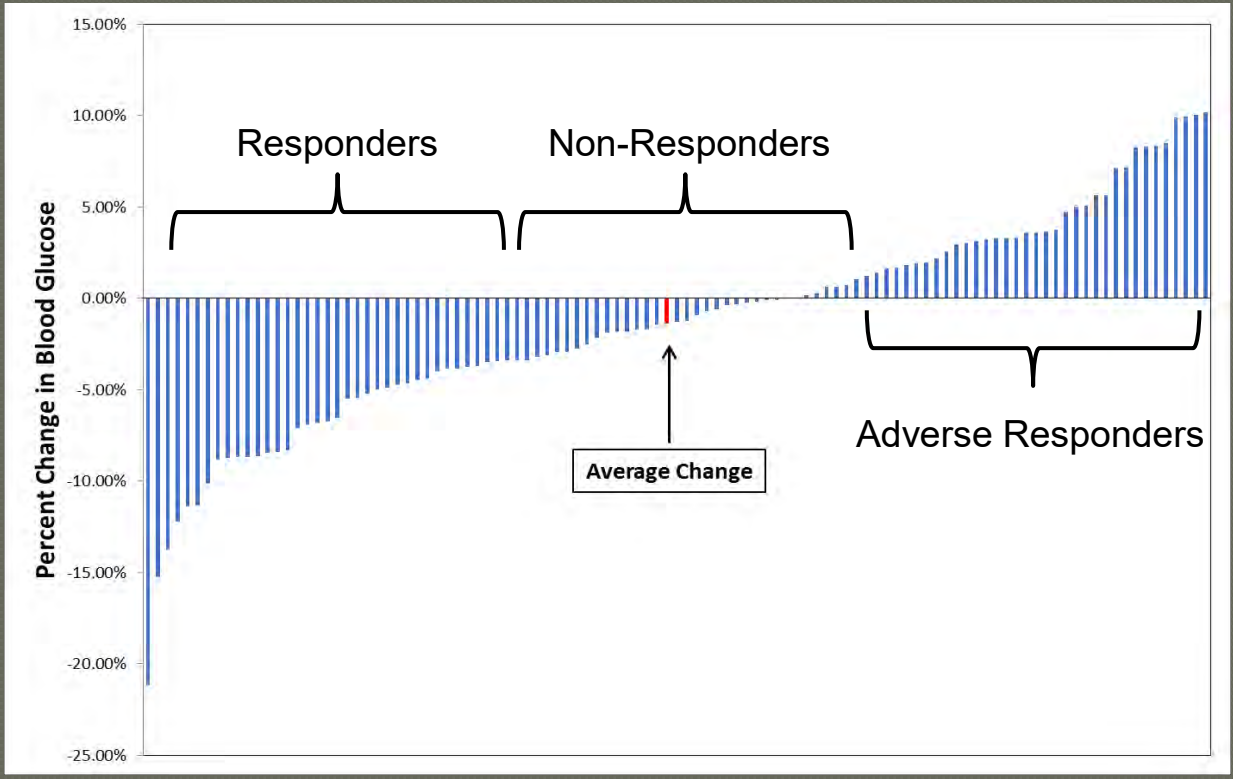
- Change in LDL-cholesterol following a 6 week supplementation with 2.5 g EPA+DHA per day
- Men (n=74; 35-70 years)



Lovegrove & Gitau, Proc Nutr Soc, 2008

Example 2: Individual Responses

- Change in blood glucose in response to 6-week consumption of traditional canola oil
- Men and women (n=106)

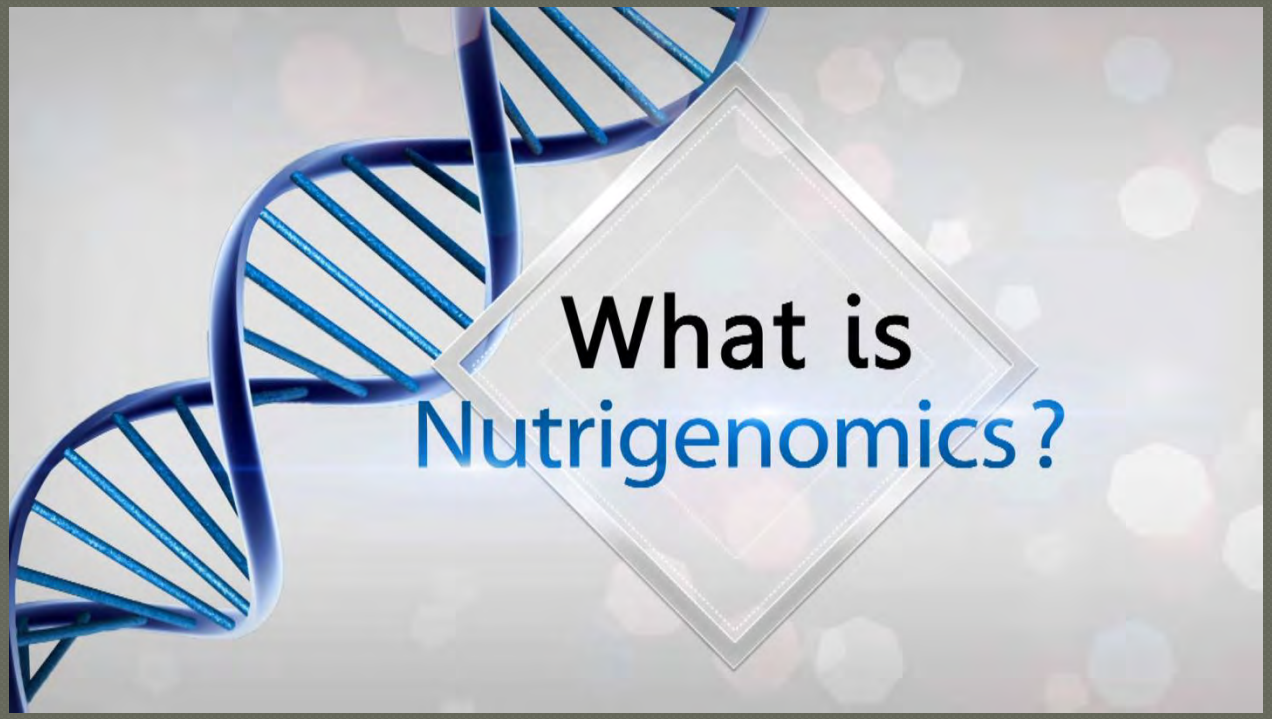


Unpublished data: Mutch DM and Jones PJ, 2018

The Role of Genetics

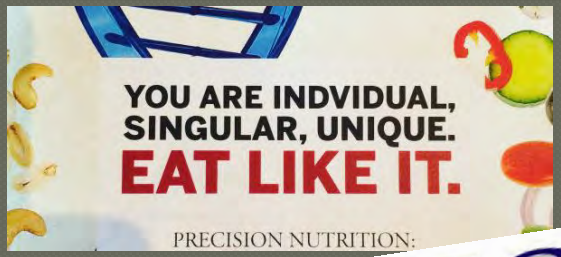
- Genes influence how people respond to foods

The Science of Nutrigenomics



- The study of how nutrients interact with our genes to influence health and disease.

Nutrigenomics is a HOT topic!



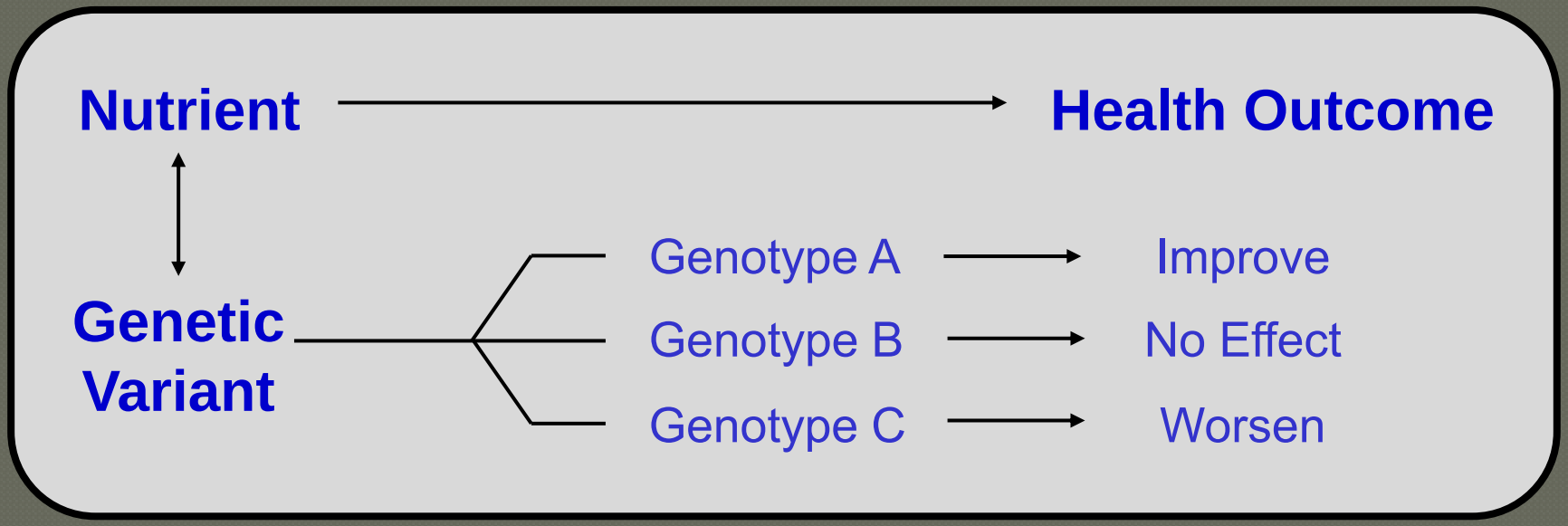
NUTRIGENOMICS
for Disease Prevention and Intervention

Advancing our Knowledge

Studying how nutrients and genes interact will improve our understanding of:

- Taste preferences: *Why do people prefer certain foods over others?*
- Food tolerance: *Why some people have a reaction to a food, and others don't?*
- Nutrient bioactivity: *How do genes influence biochemical pathways that regulate nutrient digestion, absorption, transport, and metabolism?*
- Health outcomes: *Why some people experience improvements in health, while others experience an increased risk of disease?*

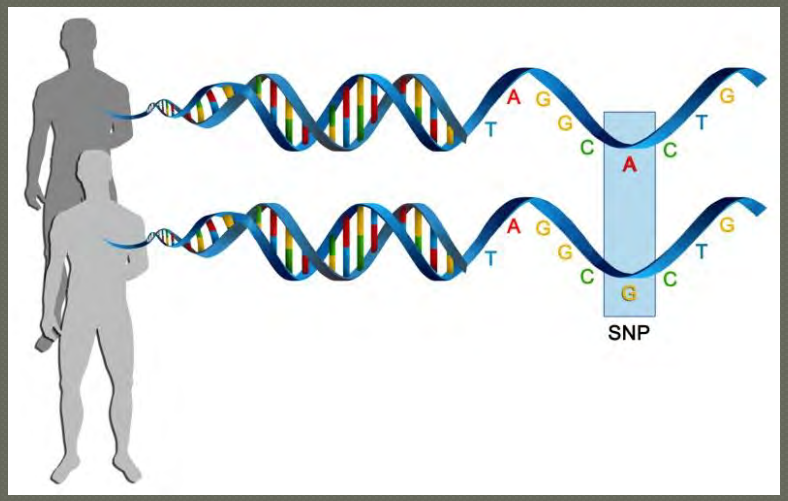
Nutrigenomics



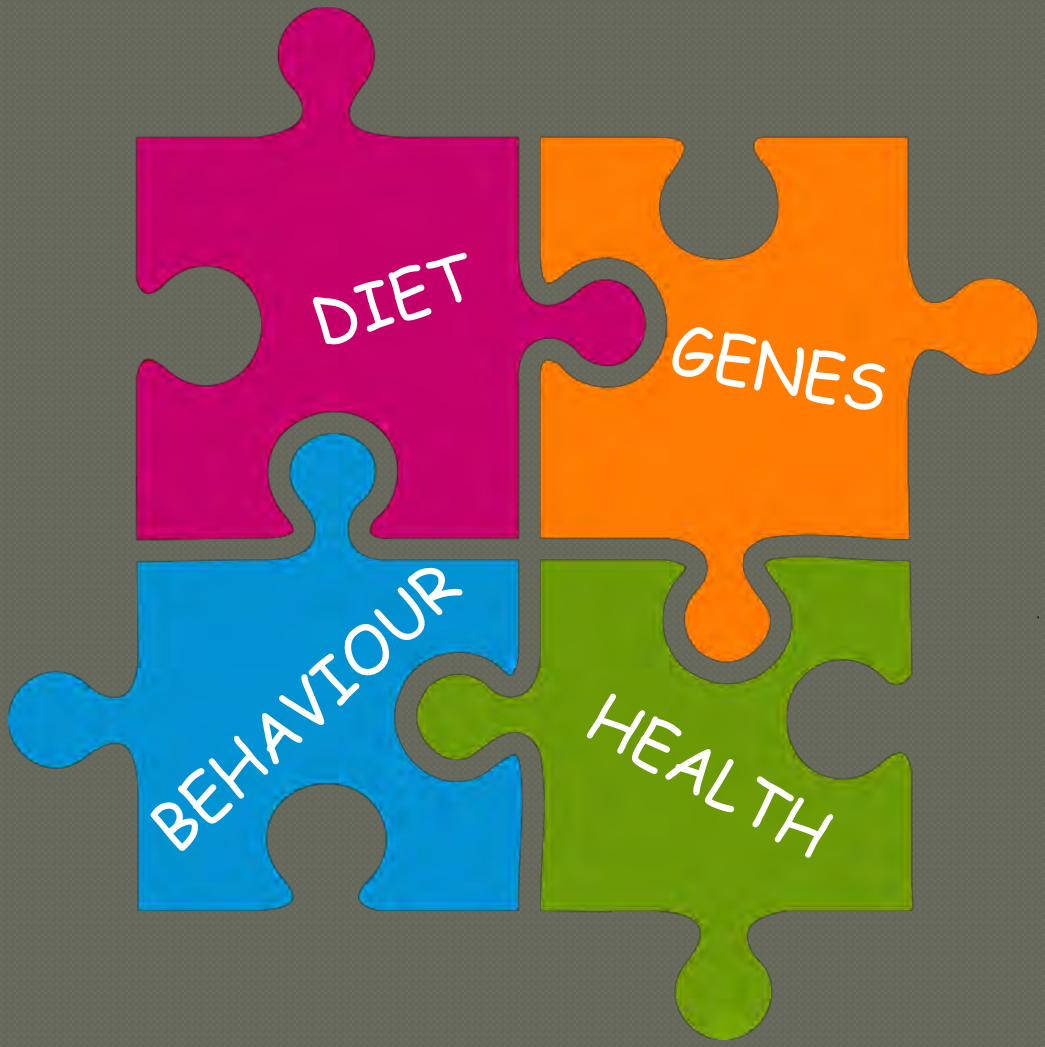
One size does not fit all.

What is a genetic variant?

- Genetic variants are Single Nucleotide Polymorphisms (SNP) that are common and spread throughout the human genome.
  - Humans are ~99.9% identical in their genome, but this still means that there can be millions of SNPs that differ between any two individuals.

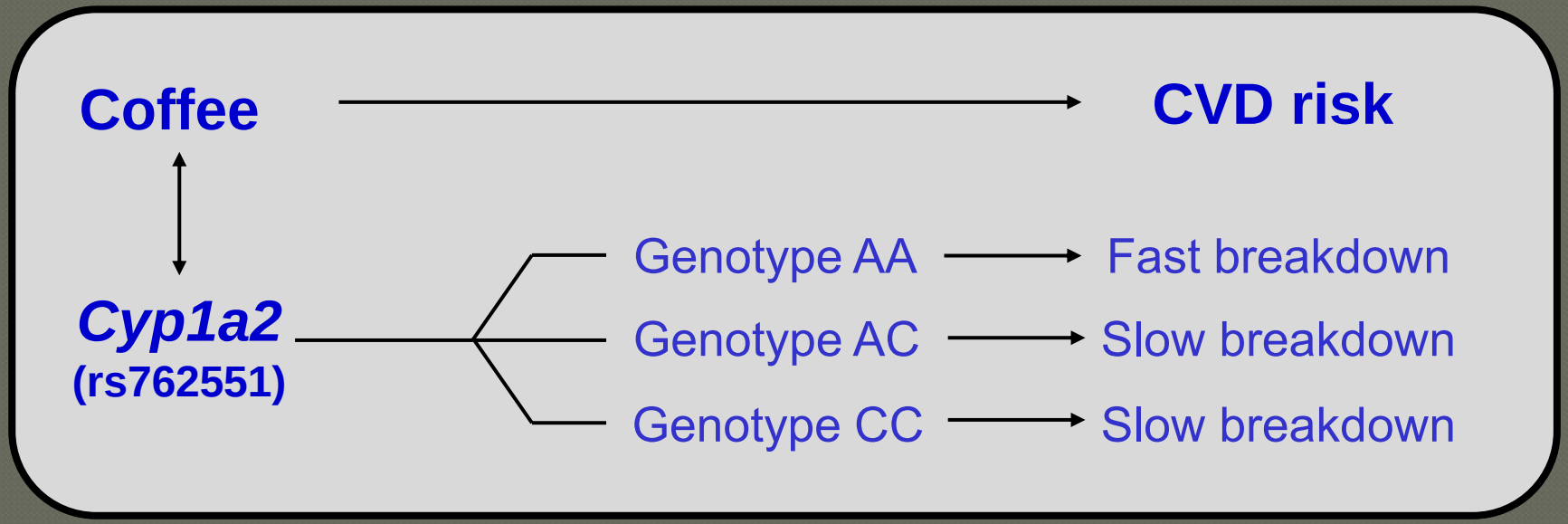


Nutrigenomic Applications



Coffee, *Cyp1a2*, and CVD

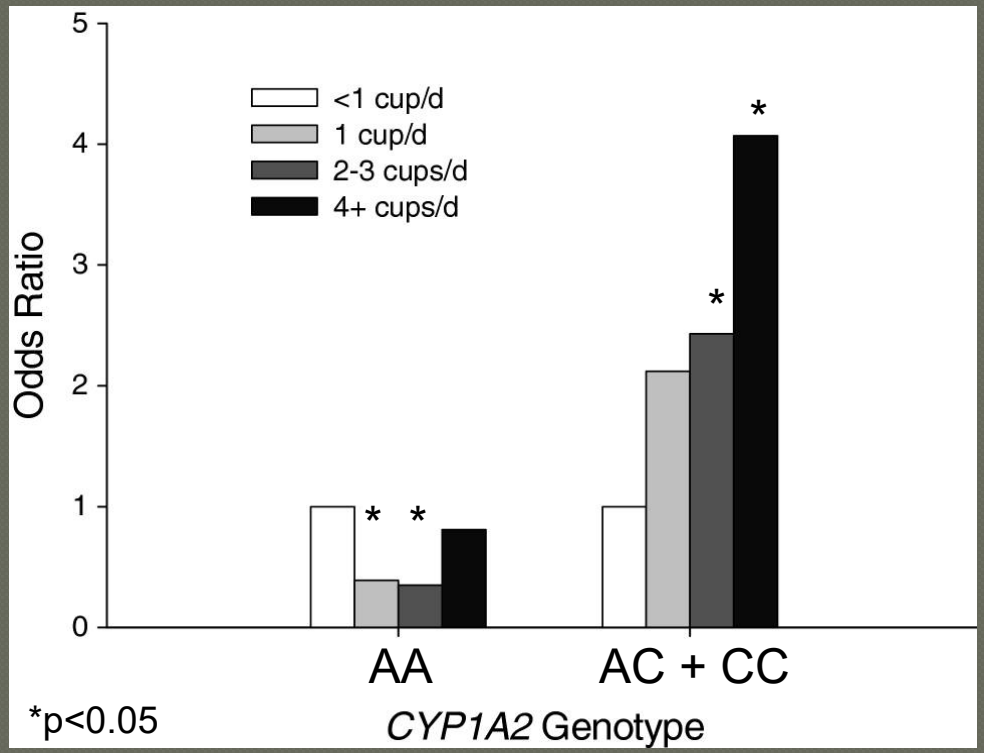
- Association between coffee intake and cardiovascular risk is controversial.
- Caffeine is broken down by the CYP1A2 enzyme.
- 37% of the general population are AC or CC.



El-Sohemy et al., Genes Nutr, 2007

Coffee, *Cyp1a2*, and CVD

- Costa Rica Heart Study (n=4,028)

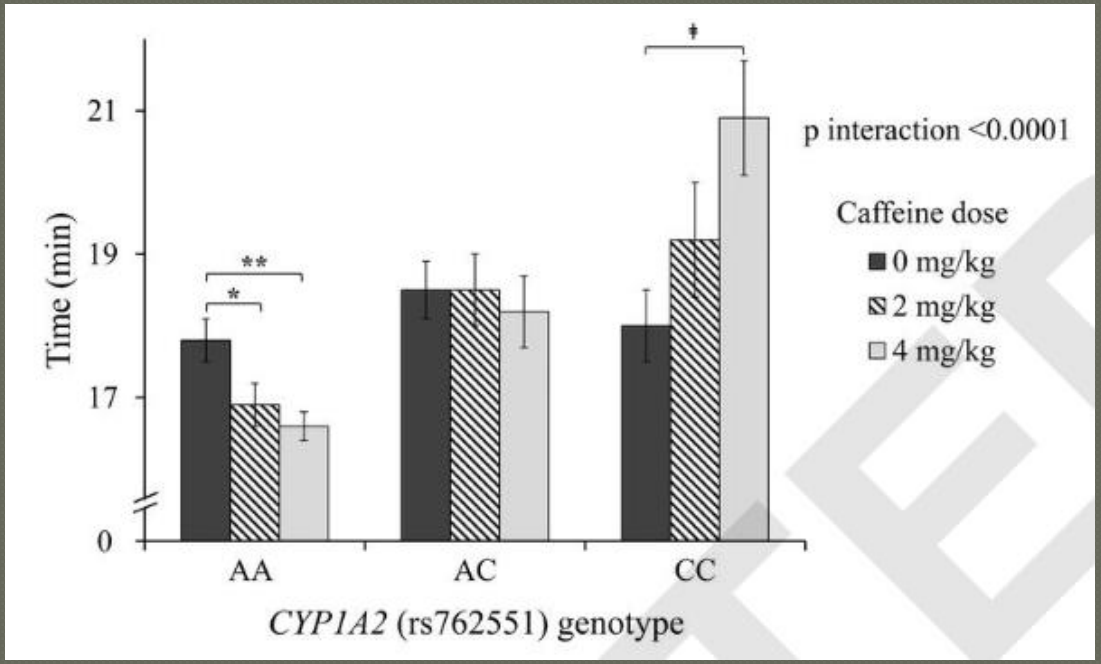


- Coffee consumption is associated with increased risk of CVD in those who have the “slow caffeine breakdown” genotype in this observational study.

El-Sohemy et al., Genes Nutr, 2007

Caffeine, *Cyp1a2*, and Exercise Performance

- Competitive male athletes (n=101; ~25 yrs of age)
- Randomized, placebo-controlled trial where participants consumed placebo (dextrose), 2, or 4 mg of caffeine per kg body weight prior to a 10-km cycling trial on a stationary bike.



AA Genotype
(fast breakdown), reduced cycling time

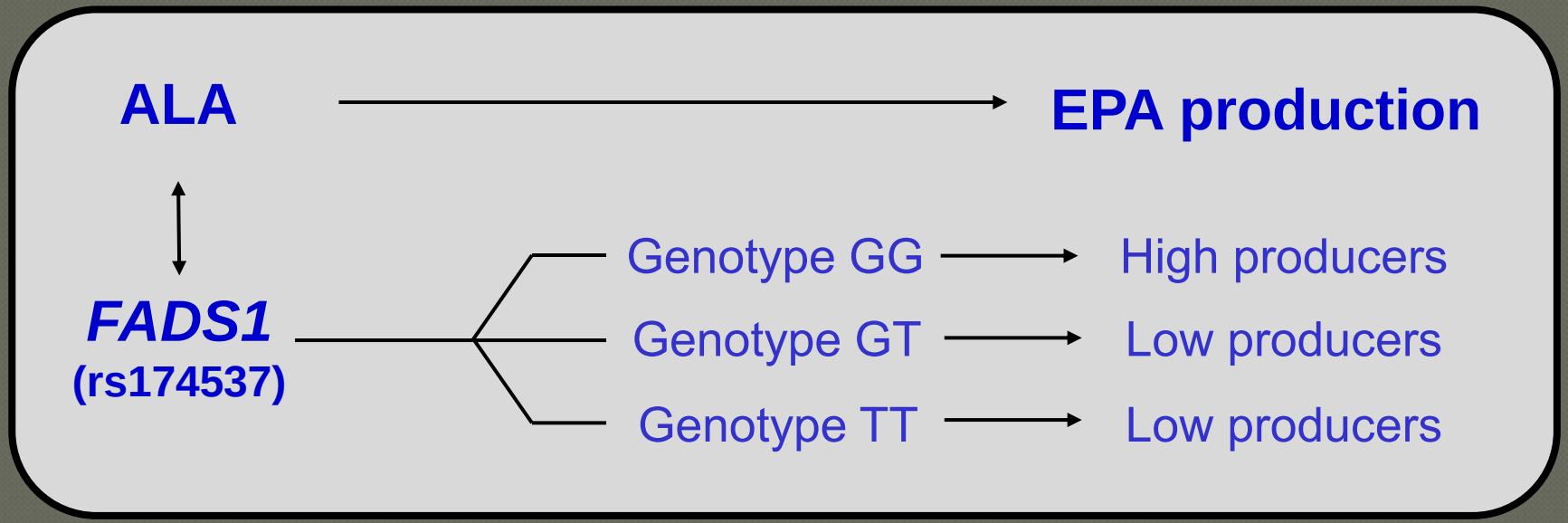
CC Genotype
(slow breakdown), increased cycling time

Guest et al., Med Sci Sports Exerc 2018

Does knowledge of personal genetic information change dietary behaviours?

Dietary Fats and *FADS1*

- Higher EPA (an important omega-3 fat) in the body reduces inflammation and improves blood lipids.
- Essential alpha-linolenic acid is converted into EPA by the FADS1 enzyme.
- 30% of the general population are GT or TT.



Changing Omega-3 Diet Habits

- Does giving a person their *FADS1* genotype lead to changes in the consumption of omega-3 fats?

Genetic Group

N=28

Non-Genetic Group

N=29

•57 young females recruited for a 3-month intervention study

- All participants received basic information about omega-3 fats
- Half of the participants given their *FADS1* genotype at study onset

•Measurements at baseline and 3-months to examine:

- Blood fatty acids and clinical markers
- Omega-3 diet consumption
- Knowledge of nutritional information

Roke et al., Nutrients, 2017

Knowledge of Omega-3 Fats

- Giving people their genetic information:
  - Increased awareness of omega-3 fat terminology ($p \leq 0.01$);
  - Rendered the basic omega-3 nutritional information more useful in the context of their genetic information ($p=0.03$);
  - Minimized barriers to the consumption of omega-3 fats
    - "Omega-3 foods are expensive": 61% in Non-Genetic group and 32% in Genetic group who selected this response
- Providing individuals with their personal *FADS1* genetic information had significant effects that may influence long-term omega-3 diet behaviours.

Roke et al., Nutrients, 2017

Dietary Behaviour Changes with Personalized Genetic Information

OPEN ACCESS Freely available online

PLOS ONE

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

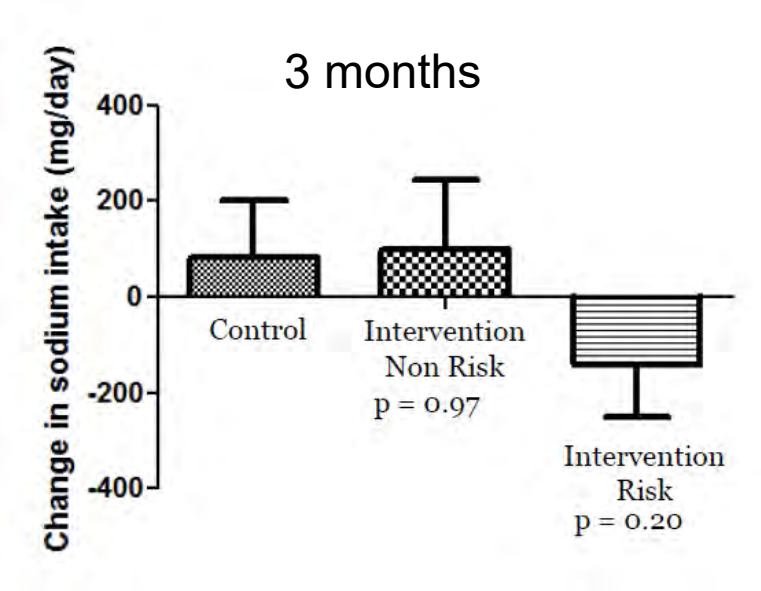
Daiva E. Nielsen, Ahmed El-Sohemy*

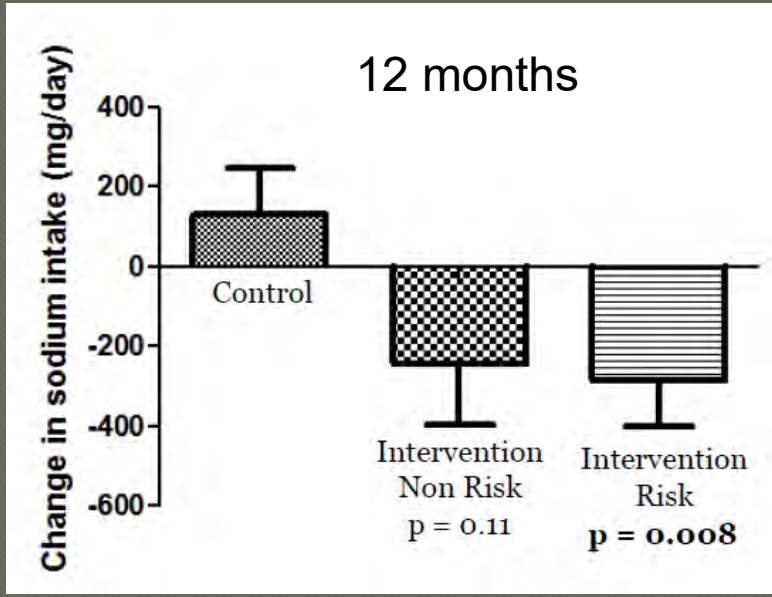
Department of Nutritional Sciences, University of Toronto, 150 College St, Toronto, ON, M5S 3E2, Canada

- Examined short (3-mo) and long (12-mo) term effects of providing personalized nutrition information related to caffeine (*CYP1A2*), Vitamin C (*GSTM1*), added sugars (*TAS1R2*), and sodium (*ACE*) to young adults.
- Food frequency questionnaires used to assess dietary intakes.

Nielsen & El-Sohemy, PLoS ONE 2014

Dietary Behaviour Changes with Personalized Genetic Information





- Changes in dietary behaviour only seen with sodium intake, where those carrying the risk allele (rs4343) in the *ACE* gene reduced salt intake after 12-mo, but not after 3-mo.
- Suggests a potential longer-term benefit from disclosing genetic information to people.

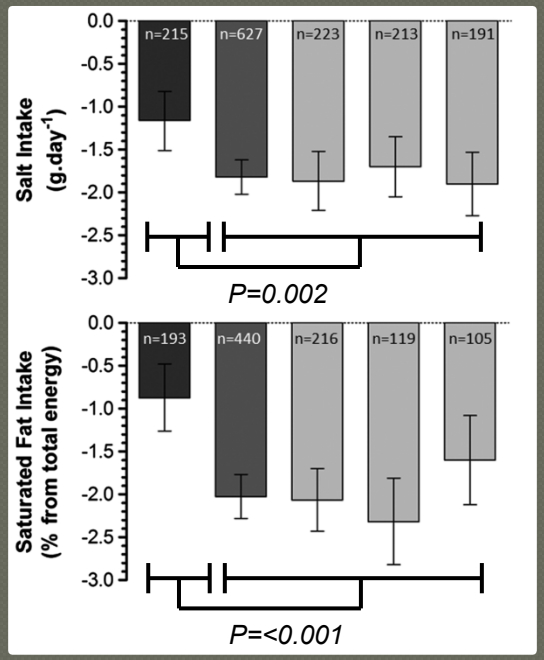
Nielsen & El-Sohemy, PLoS ONE 2014

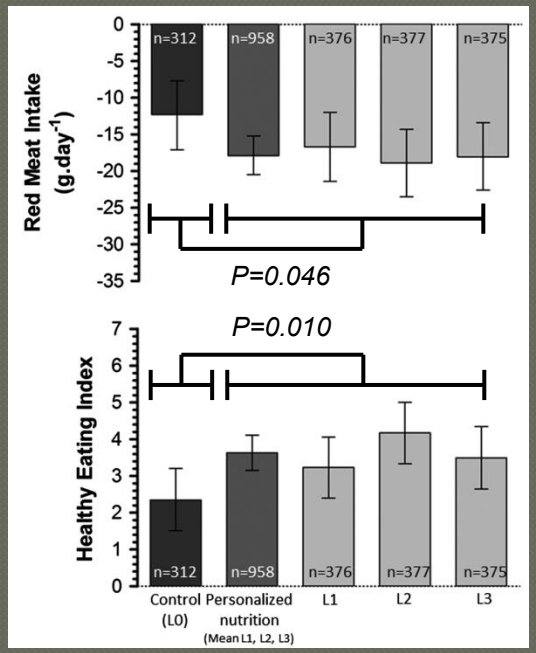
The Food4Me Study

- 6-mo, four-arm RCT conducted across 7 European countries (n=1,269 men and women) to examine the effects of personalized nutrition versus standard population advice.
  - **Control:** Non-personalized dietary advice based on standard European population guidelines.
  - **Level 1 (L1):** personalized dietary advice based on individual dietary intake data (FFQ) alone.
  - **Level 2 (L2):** personalized dietary advice based on individual dietary intake and phenotypic (blood markers) data.
  - **Level 3 (L3):** personalized dietary advice based on individual dietary intake, phenotypic, and genotype (5 nutrition-linked gene variants) data.
- Primary outcome: Changes in dietary intake after 6-mo

Celis-Morales et al., Int J Epidemiol, 2017

The Food4Me Study





- Personalized nutrition advice led to lower consumption of red meat, less salt, reduced saturated fat intake, increased folate, and an improvement in overall diet quality (HEI) compared to control.
- No difference between L1, L2, and L3 groups.

Celis-Morales et al., Int J Epidemiol, 2017

The Food4Me Study

- The authors concluded:

"Personalized nutrition advice was more effective at improving dietary behaviours when compared with conventional "one size fits all" population-based advice."

but

"There was no evidence that including phenotypic and phenotypic plus genotypic information enhanced the effectiveness of the personalized nutrition advice compared to individual dietary intake alone."

Celis-Morales et al., Int J Epidemiol, 2017

Systematic Review

The impact of communicating genetic risks of disease on risk-reducing health behaviour: systematic review with meta-analysis

Gareth J Hollands,[1] David P French,[2] Simon J Griffin,[3] A Toby Prevost,[4] Stephen Sutton,[3] Sarah King,[1] Theresa M Marteau[1]

the bmj | *BMJ* 2016;352:i1102 | doi: 10.1136/bmj.i1102

- Examined impacts on: diet (7 studies), physical activity (6 studies), and smoking cessation (6 studies).

"These results do not support use of genetic testing or the search for risk-conferring gene variants for common complex diseases on the basis that they motivate risk-reducing behaviour."

but

"nutrigenomic information may be used to inform behavioural recommendations, which are highly specific and targeted."

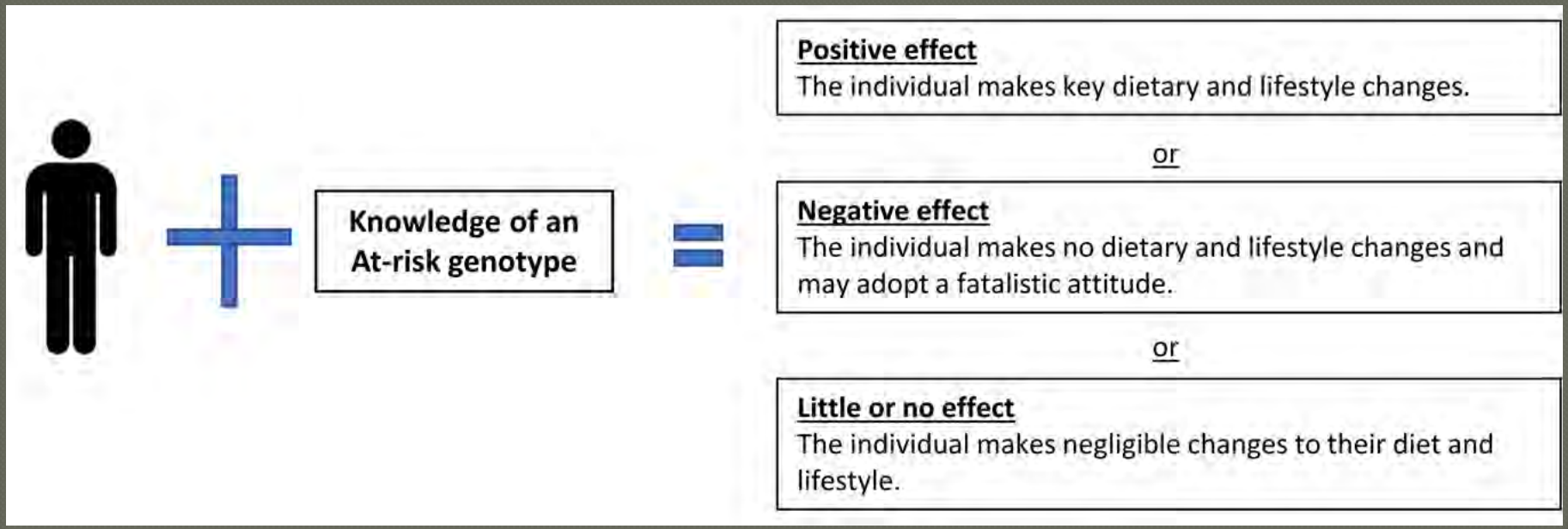
Where do we go from here?

- More research is needed to validate the use of nutrigenomics as a tool to motivate dietary behavioural changes and personalize nutrition. Numerous outstanding questions remain unanswered:

1. Will specific subsets of the population respond differently to personal genetic information?
   - E.g., men vs. women, young vs. older adults
2. Are behavioural changes sustainable?
3. Can we “overload” people with too much genetic information, causing confusion?
4. What is the best way to communicate personal genetic information to individuals?
   - Family physicians, dietitians, academics?
   - In-person consultations, phone Apps or Internet?

A Major Challenge

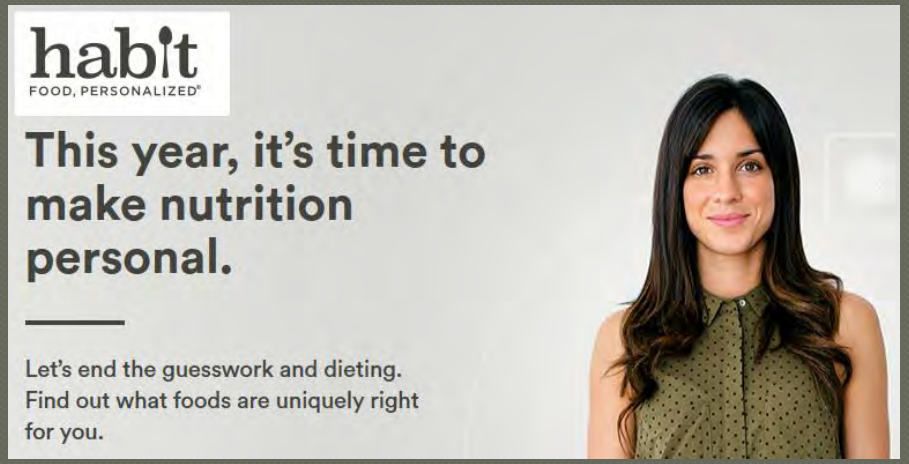
- Human Nature
  - People will respond differently to receiving their personal genetic information.



O'Donovan et al, Proc Nutr Soc, 2017

Direct-to-Consumer Testing

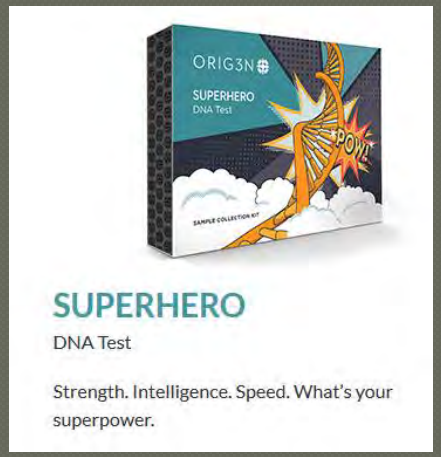
(personalized vitamin pack)



(dietary counselling and meal plans)

(information about diet & exercise)

(predicting glucose response to foods based on gut bacteria)



(even superhero powers?)

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