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An International Multidisciplinary Research e-Journal

BIOINFORMATICS: NUTRIGENOMICS & PERSONALIZED DIETS

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Abstract

The rise of nutritional genomics is ushering in a new era, where ordinary people can obtain detailed information about the makeup of their genes and therefore their ideal diet, which not only reduces significantly the chances of contracting allergy/diet related conditions, but also maximizes the health of the individual. A single letter change in the DNA of an individual could well dictate the types of food that suit you the best, and nutrigenomics can figure it all out for you.

Keywords: *nutrigenetics, nutrigenomics, personalized diets, bioinformatics*

INTRODUCTION

Nutrigenomics (nutritional genomics) is "the study of nutrition and its relationship with the genome." Post the culmination of the Human Genome Project in April 2003[1], research projects on the dynamic between the diet and the genome have grown exponentially in number. It was soon discovered that nutritional intake can both affect and be affected by the genome. This revelation has incited a flurry of endeavors to find out how and why. The body's ability to take nutrition in, use it efficiently and burn energy in an effective manner varies a lot between people. Therefore, studying an individual's DNAcan help create a personalized dietary plan.Although nutrigenomics can have remarkable effects in everyday life, very few people can claim to have benefitted from it, mainly due to a lack of awareness. In this paper, I look at the various effects and implications the DNA of an individual can have on their ideal diet.

Theory

The Human Genome in Numbers

The human genome comprises of approximately 2.9 billion nucleotides, or 30,000 genes [2], a lot of which are involved in metabolic pathways, composed of simply four chemical units, the base pairs- Adenine, Thymine, Guanine, and Cytosine (A,T,G and C). Though most genes do not directly cause complex diseases, they can enhance our receptiveness to them. The 21st century's genomic revolution [1] facilitated the study of these genes, thus creating nutrigenomics as a field.

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Personalized Nutrition

Personalized nutrition and nutrigenomics are not the same thing. Personalized nutrition, which does not involve the consideration of specific genes, has been around for ages[3]- when we tailor a person's nutritional intake to their preferences, nutrition, disease state, age, and sex, for example. The very act of omitting a particular fruit or vegetable from your diet due to personal preferences and/or allergic conditions can be termed personalized nutrition.When the personalized nutrition is gene-based, it can be termed nutritional genomics (to reduce health problems and delay the onset of diseases).

Nutrigenetic tests

On their own, our genes do not dictate the state of our health. The newly-emerging science of epigenetics -"The study of how your behaviours and environment can cause changes that affect the way your genes work"-informs us how our biochemical environment decideswhich of our genes are turned on and which of them are turned off. Our modern diet, lifestyle and environment is actually responsible for the majority of all health problems, as opposed to our inherent genetic traits. Genetic profiles, together with functional testing[6],provide information that can raptly and concisely procure the finest ways to optimize your well-being. They could show patterns and behaviours that may result in health conditionsthat do not lessen in severity, in spite of following dietary and lifestyle advice that can be generally beneficial to most other people(A one-size-fits-all approach).Getting your genetic makeup tested is thus the first step to understanding what you can do to benefit and support your health, and is a very beneficiary process through the knowledge it can bestow you with, which may motivate you to change your lifestyle for the better. Nutrigenetics tests involve collecting DNA samples from individuals and analyzing it using complex bioinformatics tools in order gauge information, such as that mentioned in the following points about the individual:

- Tendency for inflammation
- Optimum methods of weight loss
- The strength of your biochemical pathways, what you can do to enhance it and its effect on you.
- Yourdetoxification capability for various toxins that you in everyday modern life.
- your natural caffeine and lactose intolerance, and your body's ability to create vitamin A from carotenoids like beta-carotene.
- your ability to break down oestrogen, and therefore your risk for several diseases that are common to both men and women.
- Antioxidant potential
- how your genes have an effect on your mood normally and your overall ability to wear down stress.
- risk factors for insulin resistance, obesity, addiction, cognitive decline, cardiovascular disease[5], osteoporosis, IBD (Inflammatory Bowel Disease such as Crohn's disease and ulcerative colitis)
- what types of functional tests you should take into account for preventative health measures.

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Nutrigenomics vs Nutrigenetics

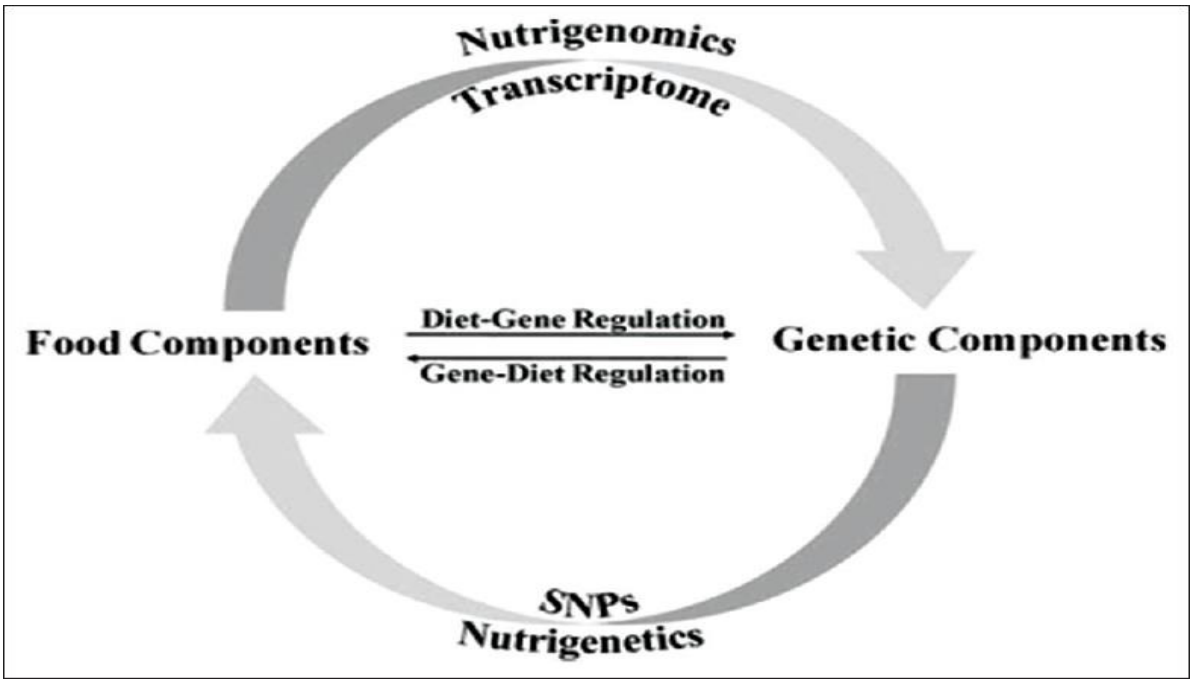

Fig.1

Figure 1 depicts the differences between nutrigenetics and nutrigenomics. The investigation of how food components dictate changes in gene expression profile or transcriptome is outlined as nutrigenomics, while nutrigenetics can be defined as the study of how genetic variations such as single nucleotide polymorphism (SNP)[4] among people affect their response to a specific food component. The two branches are often referred to as two different sides of the same coin – they face opposite directions, but are also joined together at the same time.

Genes and Food Preferences

The types of food that we enjoy and the ones that we don't have been associated with our genes. Taste receptors like T2Rs and T1R[7]may partially influence preferences for bitter or sweet foods,which can lead to overeating sweet, sugar-rich foods, while variation in ankyrin-B gene[8]can induce fat cells to store glucose at a much higher rate than normal.

A number of signals, such as blood sugar levels, the presence of certain nutrients, signals form the gastrointestinal tract (the brain-gut-microbiome axis is an imperative factor) and other sources all influence our desire to consume foods.Eating more or less than is necessary is often due to genetic factors that affect these signals.

Questionnaire

In lieu of an experiment, an online questionnaire (primary research) was conducted in an attempt to gather information about the public about nutrition and their diet. A total of 220 responses were collected over a period of two days, from which the results of the study were based on. The following questions were asked in the questionnaire :

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1) Do you have any known food-related allergies?
2) If yes, the reactions are : (severe/moderate/mild)
3) Are you currently on a diet?
4) If yes, how long have you been on a diet?
5) If you have been on a diet for more than a month, would you say that it has been effective?
6) Have you ever taken a nutrigenetics test?
7) Last Question. Do you like pineapple on pizza?

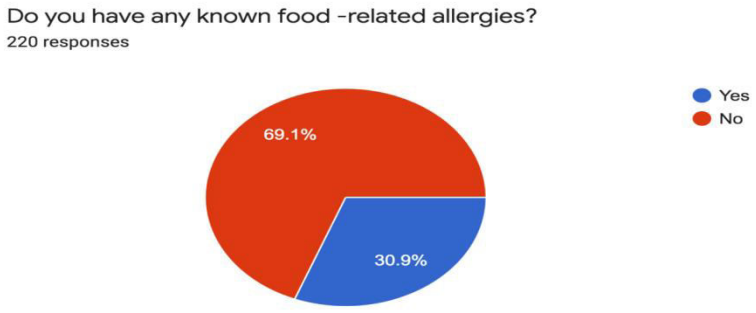
RESULT

1) 30.9% of respondents stated that they have food-related allergies.
2) Of that 30.9 percent, 14.7% have severe reactions, 33.8% have moderate reactions, and the most, 51.5% have only mild reactions.
3) 28.2% of all respondents state that they are on a diet.
4) Of those on a diet,

- 16.1% have been on a diet for more than a year
- 24.2% have been on a diet for between 6 and 12 months
- 27.4% have been on a diet for between 1 and 6 months
- 27.4% have been on a diet for more than 2 weeks
- 3.23% have been on a diet for one week
- 1.61% have just started their diet

5) Of those who have been on a diet for more than one month, 83.9% feel their diet has been effective, while 16.1% feel little to no change.
6) Only 2.3% of all people questioned stated that they have taken a nutrigenetics test previously, 215 people out of 220 having never undergone one.
7) Only 17.7% of all respondent stated that they like pineapple on pizza, while 40.9% of the 82.2% that did not like pineapple in pizza felt very strongly about it, clicking the option "never in a million years"

DISCUSSION



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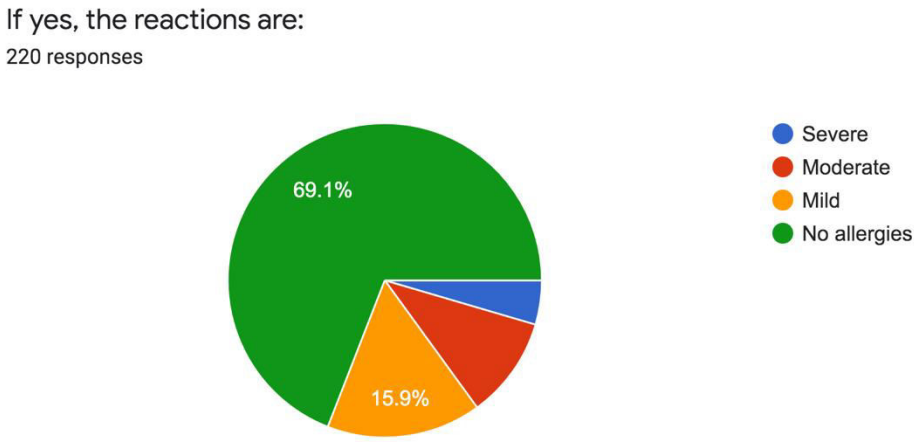
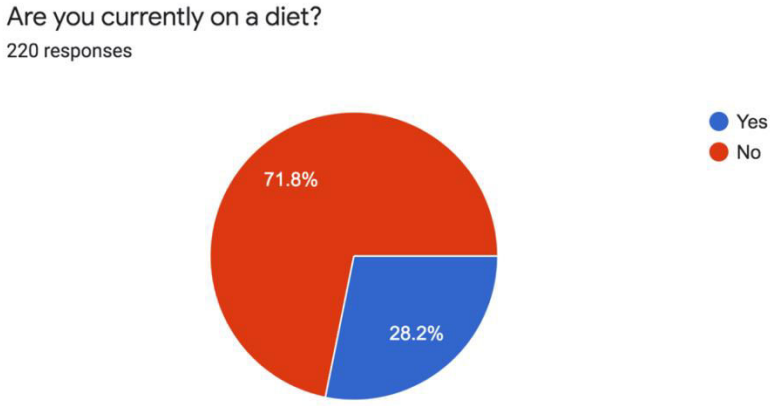
1) This question was asked to gauge the percentage of people who suffer from food-related allergies. Roughly 31% do, indicating that approximately 1 in 3 people have a food-related allergy. Allergies can also be discovered through the use of bioinformatics, in nutrigenetic or genetic tests.



2) Asked to find out the average severity of allergic reactions - 15% of all people with allergies have severe reactions, which is an alarming health condition that could be predicted through the use of nutrigenetic tests as well.



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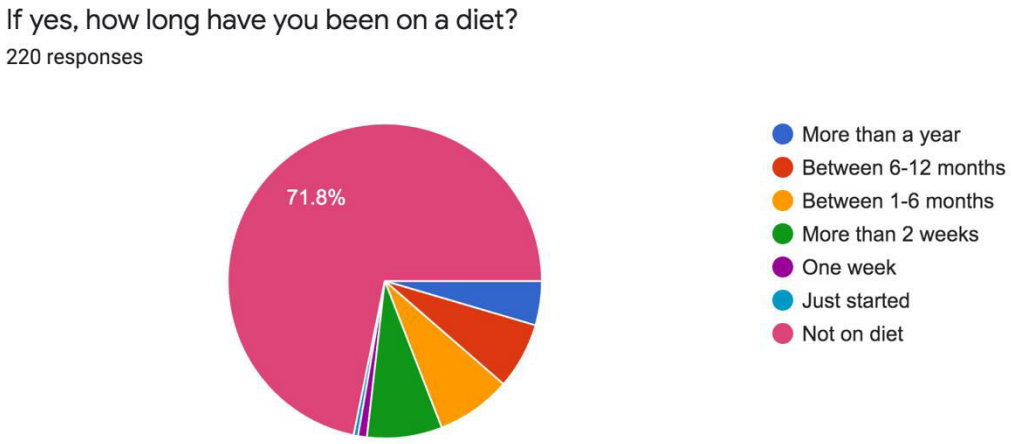
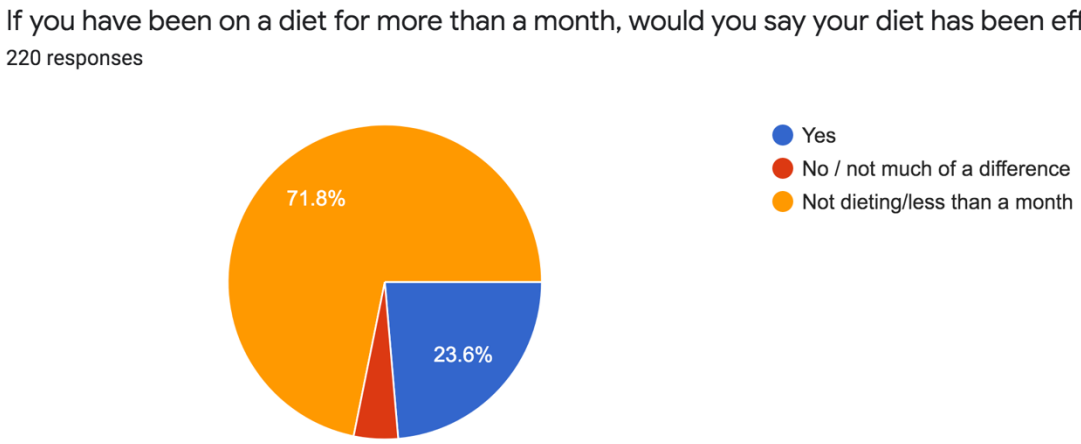
3) 28% of people asked stated that they are on a diet, this is an example of personalized nutrition.



4) The majority of people who are on a diet have been dieting for between 2 weeks and 6 months, while 17.5% have been dieting for over a year. This group of people have probably seen success in their diets, as seen in the next question, and have therefore decided to continue for a long period of time. A nutrigenetics test could inform people of a diet that they could follow in an optimum period of time, as well as the chances of a particular diet being successful



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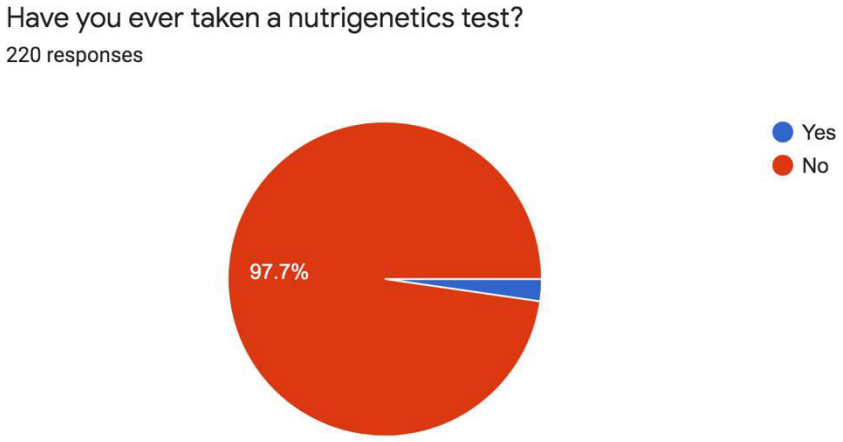
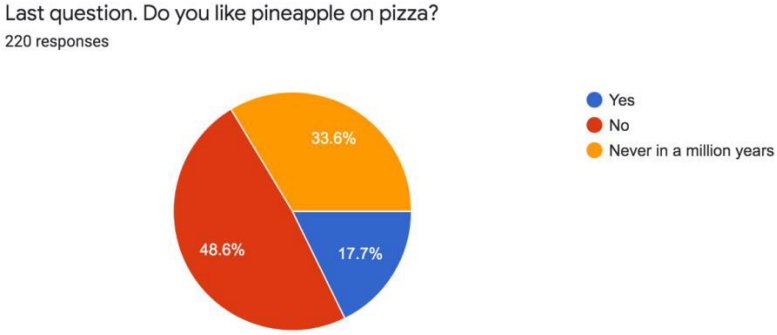
5) 84% of all respondents who are following a diet have stated that they feel their diet has been effective, which leaves 16% who felt it has made no difference. This could also have been

6) Avoided with a nutrigenetic test, as a personalized optimum diet would have been recommended. The peoples who feel little to no difference are likely following a standard diet, which is not having an effect on their body due to the individual's specific genes.



7) Only 2.3% of all people asked had ever taken a nutrigenetics test, proving how little known the sciences of nutrigenomics and nutrigenetics are. With more awareness of the same, a greater percentage of people on a diet would have been able to claim that their diet has been effective, as well as figure out any possible allergies without triggering them first.



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8) The last question had a humorous spin, but it was also asked for the purpose of gauging the wide variety of tastes of the public. A whole 82% of people stated that they do not like pineapple on pizza, with 41% of them vehemently dismissing the idea ("Never in a million years") On the other hand, 18% of all respondents actually state that they like pineapple on pizza, which goes to show how far apart people's tastes may be. Tastes like these have customized many people's diets to include foods that they like, and exclude foods that they do not, and can also constitute a personalized diet.

Conclusion

All of this just goes to show how bioinformatics could impact everyday life in profound and meaningful manners, and its effects will soon become much more prominent once the technology spreads more and more awareness has been raised. Problems such as inefficient dieting, surprising allergies, and unexpected health conditions can stop being the plague that they currently are on society, as health and fitness become the norm.

Acknowledgements

Google Forms was used to create the online questionnaire mentioned in the paper.

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