What if algorithms decided what we should eat by looking at our DNA?

Algorithm-generated diets tailored to our individual needs could bring health benefits, but at the cost of having to share our most personal data, such as our DNA. The promises are many, but so are the open questions about interactions between genes, nutrients, environment and health, and the role of socioeconomic factors underlying food choices. Precision nutrition advice, services and products will need to be governed by a range of laws and policies, as they are at the intersection between food and medicine.

What we eat and drink can be adapted to help us live with conditions such as coeliac disease, phenylketonuria and lactose intolerance, and healthy diets are an important factor in preventing non-communicable diseases such as cardiovascular diseases, type-2 diabetes and cancer. However, it is becoming increasingly clear that there is no one-size-fits-all solution when it comes to dietary recommendations. Nutrigenomics studies the relationships between nutrients, diet, gene expression and, subsequently, health. Coupled with developments in advanced technologies, such as artificial intelligence and big data, this points to a future where our diets could be specifically tailored to our individual profiles for better health outcomes. Could such precisely personalised diets become a part of precision medicine, helping us to live longer and healthier lives?

Potential impacts and developments

Rapid advances in this area have been made possible thanks to data science. The use of smart phones allows easier tracking of food and medicine intake, and biosensors of all kinds can monitor movement, sleep, blood parameters, the presence of infection and the effects of treatment. Biochemical and genetic assays can screen the human genome, the metabolome (small molecules involved in metabolism), and the microbiome (microbes living on and inside the human body). ‘Deep phenotyping’ can unveil previously unknowable details of disease in individuals. The cost of such analysis is decreasing. At the same time, data processing capacities are growing thanks to advanced algorithms that extract meaningful patterns from big data. For example, one algorithm has been trained to predict the glycaemic response after a meal, on the basis of blood parameters, dietary habits, anthropometrics, physical activity and gut microbiota. In a modified diet based on this algorithm, test subjects improved their blood glucose levels and microbiota configuration. Research also shows that individuals, even identical twins, may respond differently to the same foods. This is where precision nutrition comes in, as it seeks to understand and manipulate the complex relationships between an individual’s metabolism, microbiome, genome, phenotype (the observable physical properties of an organism), lifestyle, and outside influences on the one hand, and their nutrition on the other.

The potential is fascinating but, for now, the science is not reliable enough to support precision nutrition services. More research and stronger evidence are required before scientists will be able to point out with confidence, and algorithms effectively predict, gene-diet-health relationships and outcomes. Before precision nutrition can become a reality, desired health outcomes and ways to identify and measure them will need to be defined. This will be highly important for people suffering from several or particularly complex health problems. For them, the same nutrients or foods may help with one issue, but worsen others, which
What if algorithms decided what we should eat by looking at our DNA?

means that the algorithms would have to 'know' what to prioritise when giving dietary advice. Moreover, as we grow older and our bodies and health change, we will have to regularly re-evaluate our needs and our bodies’ responses.

Another question is what conditions, health problems or genetic predispositions can really be influenced by diet. We eat a wide variety of foods, and our biology has a complex relationship with the factors shaping our environment. This alone represents a great challenge for nutrigenomic research. Furthermore, groups with a low socioeconomic status often make less healthy food choices. Precision nutrition advice alone is unlikely to help this situation. It remains to be seen whether such interventions could play a role in countering the obesity epidemic and decreasing public healthcare costs.

A range of soft impacts – such as more pressure to adapt to trendy, healthy behaviours, with related problems of self-image – is also probable. Preparing and eating food plays a strong social and psychological role. As we hand over more authority and autonomy to algorithms, any deviation from the prescribed diet may leave us with a feeling of guilt, draining some of the joy we get from food. Finally, focusing excessively on molecular-level health outcomes by following nutrition advice may affect our perception of health.

Another challenge relates to consumer protection: claims linking genetic information and dietary advice with effects on health need to be evidence-based and at the same time easy for ordinary people to understand. Ultimately, consumer acceptance of this technology will depend on whether the precision nutrition approach delivers clear benefits, with acceptable trade-offs (e.g. sharing of personal data) and price.

Nevertheless, early applications could target groups that have similar dietary requirements or roughly the same health status (for instance, pregnant women or the elderly), or provide information on how our bodies react to specific foods. More futuristic scenarios may involve continuous data gathering facilitated by omnipresent sensors in our living space, and in and/or on our bodies, to calculate optimal daily nutrition requirements and send the information directly to our household food printer.

**Anticipatory policymaking**

Neither the EU nor its Member States have legal instruments dealing specifically with precision nutrition services. To fill the gap, various existing pieces of legislation could be applied and some new ones may have to be adopted. One of the key challenges is that personalised nutrition is at the intersection between food and medicine, because some personalised nutrition products could help a person prevent the development of a disease to which they are genetically predisposed.

From a legal and regulatory perspective, there are several important aspects that need to be considered. Precision nutrition services are data intensive, as they rely on personal health data and genetic data for the advice they provide. This triggers questions about data protection, privacy and intellectual ownership. Whether it is developing and selling services and products or collecting data through medical devices and genetic testing, all these activities need to meet a set of rules and standards. Marketing activities – such as advice and claims about health effects made as part of precision nutrition services – would have to be regulated as well, to ensure that the information supplied to consumers is evidence-based and not misleading. Similar rules are already built into the Regulation on nutrition and health claims for foods. Protecting those receiving precision nutrition advice may mean adapting the consumer rights framework.

The research behind precision nutrition needs financial support to gather consistent high-quality evidence about why and how people respond differently to the same food, and what kind of approaches are effective and for whom. The cost of the benefits people can obtain from such hyper-personalised dietary advice will largely define its accessibility to those outside a small group of wealthy users. Nevertheless, even with affordable effective precision nutrition services, a broad set of policy measures is needed to make healthy eating and lifestyle choices easy and safe for everyone.