Analysis of DTC nutrigenetic services in Italy: state of the art, agreement to the ESHG statement and future outlooks

Vincenzo Cinque[1], Fabio Acquaviva[1], Paola Vergara[1], Alessandra Cianflone[2], Imma Castaldo[1], Antonella Monticelli[3], Sergio Cocozza[1], and Michele Pinelli[1]

[1] Dipartimento di Biologia e Patologia Cellulare e Molecolare "L. Califano", Università degli Studi di Napoli "Federico II", Naples, Italy

[2] Dipartimento di Medicina Clinica e Sperimentale, Università degli Studi di Napoli "Federico II", Naples, Italy

[3] IEOS-CNR, Naples, Italy

Abstract

Background: In both USA and Europe operate companies selling Direct-to-consumer genetic tests (DTC). These tests are offered to healthy people aiming to identify predispositions to complex diseases and to take preventive measures. Several DTC-nutrigenetic tests (DNTs) are available on the market. They propose the definition of a personalized diet, on the basis of the investigated genetic variants, which would reduce the risk of developing those diseases which have been associated to specific genetic markers. However, the risk/benefit balance of exposing unselected population to genetic testing without any medical surveillance is far from be established. Furthermore, it lacks an accepted procedure to select which genetic markers needs to be investigated, to evaluate their specific role and, as consequence, to define a personalized diet. Within this context, the European Society of Human Genetics (ESHG) released a statement regarding the DTC tests that has been ratified by several national societies including the Italian one.

In the present study we analyzed the DNT offered in Italy, the state of the art and the abidance with the ESHG statement.

Methods: We queried web search engine for the DNT offered to italian population, portraying a non-specialized customer. We examined the DNTs vendor websites and/or directly contacted the companies to collect information on: 1) genetic marker essayed, 2) diseases and phenotypes considered and 3) kind of dietary advices provided. Finally, we evaluated the abidance to the ESHG statement. The study was conducted between November, 2010 and May, 2011.

Results: Six companies operate in Italy with a total of seven different DNTs offered. Both studied phenotypes and investigated genetic markers were very different among companies, with a relative higher level of agreement for phenotype than for genes. None of the companies described the methods used to select markers and to define diet advices. None of the companies showed a complete agreement to the statement of the ESHG.

Conclusion: Although DNT companies' efforts are worthy, a standardization of methods and a more strictly agreement with ESHG statement should be encouraged.

Abbreviations: DTC, direct-to-consumer genetic test; DNT, DTC nutrigenetic test; ESHG, European Society of Human Genetics.

Introduction

The identification of the genetic basis of several common multifactorial_disease and the perspective of the application toward a personalized medicine led, in the recent years, to the development of an increasing number of predictive genetic tests. In addition, the continuous biotechnological advancement is reducing the costs of genetic testing and is creating potential business opportunities. Indeed, in North America and in Europe, several companies have been established to sell “direct-to-consumer” genetic tests (DTC).

These tests are offered to unselected customers, usually through websites or pharmacies, and without a specific medical counselling. In the typical procedure, the customer purchases the test online, receives a kit to collect exfoliated oral cells and sends the sample back to the company. Company extracts DNA, characterizes a set of genetic markers and email the results with variable ancillary information, such as results interpretation and/or personalized advices.

Undoubtedly, DTC have potentially important advantages. Customers can have an easy access to genetic testing [1], acquire consciousness of their disease risk and receive personalized suggestions to modify the lifestyle [2, 3]. However, these tests are proposed to healthy people without the mediation of any healthcare professional whereas all the persons undergoing a genetic test should receive a pre- and a post-test genetic counselling explaining scope, limitations and uncertainty of the results obtained. Moreover, the genetic-tests interpretation have the peculiarity to be perceived as definitive and unmodifiable, therefore, even when negative, a clear explanation of the real prediction ability of test should be provided. All these concerns are amplified in the case of complex disease where the prediction ability of these tests is largely unproven [4, 5, 6, 7]. The genetic basis of most complex diseases are, in fact, still in active state of definition only partially understood and the methods to calculate the risk for a single individual are not defined [8, 9]. Anecdotal cases suggest that different companies assessed different risk to the same individual for the same phenotype [10].

Among others, nutrigenetic DTCs are becoming very popular. Many companies are, in fact, selling DTC nutrigenetic tests claiming to identify individuals with genetic risk to develop diseases, such as type 2 diabetes and osteoporosis, and provide them with tailored nutritional advices or a personalized diets [11]. Unfortunately, only in few cases an agreement among researchers on which diet suggest to individuals with specific genetic background has been reached.

For these reasons, the selling of DTC tests in Europe is rising several concerns among the scientific societies and the regulating bodies. The European Society of Human Genetics (ESHG) released a statement on DTC genetic testing for health related purposes that has been approved by the Società Italiana di Genetica Umana (SIGU) [12, 13]. This statement highlights several relevant issues: the need of a medical counsellings before and after each test, the transparency in the communications process, the legal age for testing; the acceptance of an informed consent, the respect for the customers' privacy.

In the present study we analyzed DNTs available in Italy, their state of the art and their abidance with the ESHG statement.

Data and methods

Three independent researchers queried a web search engine for DTNs offered to Italian population. The searched keyword was: "nutrigenetics" on *Google Italia* (http://www.google.it/) and the first 100 results were screened. The results included private practices and companies, we only selected those companies offering genetic tests directly to customers without a genetic counselling.

We examined, as we were the customer, the companies' websites and/or directly contacted them to collect further data. We collected information on: investigated clinical phenotypes, genes and SNPs assayed, methods and algorithms used for the risk prediction, costs of the services, conflict of interests (i.e. nutritional supplements selling), legal and ethical aspects. We also assessed if companies provided scientific references supporting their test, how those references were obtained and how they defined the predictive value for each investigated SNP.

We considered as "output" of the DNTs the answer that the customer automatically receives after testing and not any other additional information that he/she could potentially obtain by contacting help desks or other customer services.

We also checked if other supplementary services were offered to customers by the companies, i.e. if the companies offered the chance to meet or to talk to a specialist (medical doctor, genetic counselor, dietitian) or if a tailored help desk service was provided (with professional or non-professional employees). Finally, we searched for laboratory quality certifications on companies websites.

All the data were collected from November, 2010 to May, 2011.

To assess the overlap in terms of common clinical phenotypes and genes analyzed by different companies, we used the Jaccard index (J) [14]. According to this test, two sets of items are as more similar as the J is higher. J is defined as the ratio between the items that are common to the two sets (intersection) on all the items that belong to one of the sets (union). Defining A and B as the items of the first and second set, respectively, the J can be defined as:

$$J(A, B) = |A \cap B| / |A \cup B|$$

To compute genes overlap between companies, we searched for unequivocal IDs in the NCBI Entrez Gene database. We did not obtain exhaustive SNP data, because the information provided by the companies were, usually, incomplete. We manually grouped the clinical phenotypes declared by companies in few categories.

To evaluate if companies met ESHG statements' criteria [12], we collected information in a structured way. Firstly, we designed an evaluation list (Table 1), in which each point refers to an aspect of the ESHG statement, then we collected data and compared them with the statements.

RESULTS AND DISCUSSION

DNT services

We found six DTC Italian companies offering seven different DNT (Table 2). One company, G&Life, offering two DNTs, namely: *G-Diet Lifeplan* and *G-Profile Nutrigenetics*.

All DNTs were presented in websites with different extent of documentation and explanations. Regarding the sample collection, six DNTs send sample collection kits at home (*G-Diet Lifeplan*, *G-Profile Nutrigenetics*, *Genoma DNT*, *Nutrisalus.Gen*, *Test Nutrigene* and *Kriagen DNT*), four collect samples by inviting customers in their laboratories (*Genoma DNT*, *Nutrisalus.Gen*, *Test Nutrigene* and *Kriagen DNT*), one through affiliated pharmacies (*Vitalybra*), and three through health professional practices (*G-Diet Lifeplan*, *G-Profile Nutrigenetics*, and *Vitalybra*). All DNTs collected sample by means of a buccal swab.

Table 3 reports the main characteristics of the considered DNTs. We revealed a cost difference among the companies that can be accounted to the different number of genetic markers analyzed and to the differences in services offered.

Analyzed genes, SNPs and phenotypes

Companies communicated at some extent the genes analyzed for each DNT (Table 3 and Table 4). However, only for four DNTs the complete list was provided, while for the three others the information were incomplete. For instance, *Nutrisalus.Gen* listed 19 single genes and a group of non-specified interleukin genes, while *Test Nutrigene* and *Kriagen DNT* did not specified which genes were assayed for celiac disease. The information regarding the SNPs were more incomplete (Table 3 and Table 4). Only *Vitalybra* provided accurate information about tested SNPs (including the dbSNP *reference SNP code*) and the at-risk genotype for each phenotype. *Test Nutrigene*, *Kriagen DNT* and *Genoma DNT* provided enough information to identify SNPs in databases, while *Nutrisalus.Gen*, *G-diet Lifeplan*, *G-profile Nutrigenetics* did not provide information about SNP (Table 4). Although this lack of information, when possible we tried to extract the gene and SNP lists for DNTs (Table 4 - S2).

We looked for genes assayed by more DNTs (Figure 1) and found that no gene was analyzed by all the DNTs. This would suggest that scientists and companies have still not reached an agreement on a core set of relevant genes with a nutrigenetics impact. On the contrary more

than a third of genes (22 out of 60, 37%) were tested by a single DNT. Despite this little overlap, it is remarkable that the two most studied genes, LCT and MTHFR (tested by six DNTs), are among the few ones that have polymorphisms with a proven importance in nutrigenetics.

The assayed SNPs covered a wide spectrum of functional roles. Some polymorphisms were predisposing factors for multifactorial diseases, usually associated with a mild increase of disease risk. Others, such as those regarding celiac disease were susceptibility factors with a high negative predictive value [15, 16]. Finally, few ones were mendelian disease-causing mutations, as the *ALDOB* gene mutation for the familiar fructose intolerance [17] and the *APOB* gene (R3500Q mutation) for the familial defective apolipoprotein B-100 [18]

To assess how companies selected genes and SNPs we evaluated if DNT companies reported reference studies and described methods used to select them (Table 3). Even if with a different level of accessibility, only *Genoma DNT* and *Test Nutrigene*, clearly reported the scientific studies used for the selection. No company declared how reference studies were selected. Nevertheless, authors believe that defining a-priori criteria to select reference studies would help to proceed to a non-arbitrary selection of markers avoiding selection bias. The ESHG statement invites companies to provide accurate and accessible labelling information about genetic tests. By this point of view, the incomplete disclosure of data and procedure used by companies seems not to meet that statement.

We evaluated the clinical phenotypes considered by DNTs and checked whether there was an overlap among DNTs. It resulted that phenotypes analyzed were widely different and the most analyzed pertains to moderate hyperhomocysteinemia, primary lactose intolerance and dyslipedemia. (Table 6). The clinical phenotypes are in many cases diseases preventable by a modification of lifestyle. In this light, it seems that DNTs would meet customers wishes as detected by an UK survey [19]. In that study most of the potential customers declared that

they would perform a DTC genetic test to reduce their risk to develop diseases by modifying their lifestyle.

Regarding the nutrigenetics, a clinical phenotype of relevance is the obesity. Although there are no direct evidences that individuals undergoing a DNT wants to lose weight and few scientific evidences supporting the utility of a genotype-specific dietary plans in losing weight [20, 21], appear presumable that weight control could be one of the major drive for individuals undergoing these kind of tests. Nevertheless, only a few of DNT consider obesity (8%).

Finally, the Jaccard analysis showed which DNTs are more similar for assayed genes and clinical phenotypes (Table 5). We detected that overlap both in terms of genes and phenotypes was generally low, however, in all cases the jaccard index was higher for phenotypes than for genes. This could suggest that a relative higher level of agreement has been reached for relevant phenotype in nutrigenetics than for genes.

Nutritional recommendations

Outputs of DNTs resulted to range from a complete dietary plan to the sole list of assayed SNPs (Table 3). *G-diet Lifeplan*, *G-profile Nutrigenetics* and *Vitalybra* elaborated an independent semi-quantitative risks for some diseases on the basis of the genetic test. *Genoma DNT* and *G-diet Lifeplan* returned a personalized dietary plan, while *Test Nutrigene*, *Vitalybra*, *G-diet Lifeplan* and *Nutrisalus.Gen* provided nutritional advices on the basis of the carried variants for specific phenotypes. *Kriagen DNT* and *Genoma DNT* only reported a list with the results of the genotyping without any advice. They offered as basic option the genetic test without an interpretation, nevertheless, *Genoma DNT* offers, as additional service, a help desk with molecular geneticists and/or a nutritional consult in Rome (this latter with fee) and *Kriagen DNT* offers an help desk with molecular geneticists and dietitians.

Regarding how the nutritional advices were formulated, all the DNTs used genetic data plus, in some cases, other information. For instance, to formulate a complete dietary plan *G-diet Lifeplan* uses genetic data, a lifestyle questionnaire, and a PTC (phenylthiocarbamide) paper test. *G-profile Nutrigenetics* uses only genetic data and the PTC paper test. *Vitalybra*, *Test Nutrigene*' and *Nutrisalus.Gen*'s results rely on the sole genetic data. Nevertheless, companies did not describe methods used to predict disease risk and to define the advices.

Agreement to the ESHG statements

In this section we focused on the ethical and legal issues of about DNTs raised by ESGH statements. We formulated an evaluation list (Table 1) to compare the companies policy agreement to the ESHG statement. According to results of our list, none of the companies showed a full agreement with the ESHG statement (Table 7). We would underline that we did not purchase any DNT. We based our analysis only on information present on websites and collected by direct contacts with companies and resellers. Part of the information considered in this section, especially regarding privacy and biological sample destiny, could be potentially reported in other documentation, i.e. informed consent and contracts, only accessible to customers and therefore unavailable to us.

ESHG statement indicates pre-test and post-test genetic counselling as mandatory and indicates as preferable that they are performed by counselors external to the company. Of the considered DNTs only five offered an help desk with the possibility to talk with a genetic counselor, a physician, or a dietitian. We believe that providing an help desk cannot be considered equivalent to a genetic counselling, however, this failure probably should be accounted more to the nature of DNTs (direct to consumer) than to the single companies strategies. Probably, the main issue raised by this type of services is the exposition of large part of asymptomatic population to genetic tests without the intermediation of a health professional. The opportunity for people to access to valuable information for lifestyle

modification faces the risk that an individual can overestimate a test result indicating an increased risk or, on the contrary, feeling too reassured by one with a reduced risk.

Another important concern was the potential conflict of interest of companies offering DNTs. None of them clearly stated that no conflict of interest exists. However, when company websites were carefully analyzed, we revealed that a potential conflict of interest may occur for at least two companies (also selling nutritional supplements). In fact, they sold DNTs and advice nutritional supplements, in one case also on the basis of the genetic test results.

Regarding personal information privacy and biological sample destiny we revealed different level of disclosure among companies. Five of them assured that personal information are treated in a confidential manner and that biological sample will be destroyed after the analysis. For the remaining two companies we could not obtain information on this regard. In details, *G-diet Lifeplan*, *G-profile Nutrigenetics* declared that biological and personal data of the customer are treated in confidential manner and that are not communicated to other subjects. The biological samples are treated in an anonymous way, lab operators do not know the identity of the customer, and samples are destroyed at the end of the analysis. *Genoma DNT and Kriagen DNT* declared that biological and customer personal data are treated in confidential manner and samples are destroyed at the end of the analysis. When contacted *Nutrisalus.Gen* operators declared that access to personal information is restricted to authorized operators and that details on personal information privacy and sample destiny are reported in the informed consent. We could not obtain on *Vitalybra* website or contacting *Vitalybra* pharmacies any detail regarding personal information privacy and biological sample destiny. When contacted, *Test Nutrigene* operators did not disclose any clear information on procedure regarding personal information privacy and biological samples destiny, declaring that DNA extraction and genotyping were performed by an external laboratory.

All the DNTs, were available for minors. This point is in clear contrast with the ESHG statement on direct-to-consumer genetic tests [12] and with ESHG recommendations on genetic testing on asymptomatic minor [22]. According to published recommendations, testing on a minor should be performed only for diseases substantially influenced by genetic variations, for which a medical procedure is needed to prevent or reduce the burden of the disease and for which a delay until the legal age should be avoided. DNTs does not belong to the this type of genetic testing, therefore, testing on minors should be avoided.

One of limitation of the study is the possible skipping of DNTs services operating in Italy. However, we used a procedure similar to that of a customer that is looking for DNTs on internet, the web search was repeated by three operators and the first 100 results were analyzed, probably more than those usually considered by a typical internet user. A further limitation would be that we did not purchased any DNT, therefore we did not experience the testing procedure, nor we consulted contracts, informed consents and answers. However, we were particularly interested to the pre-test phase, in order to known information provided to customers before they decide to perform a DNT.

CONCLUSION

Direct to consumers-nutrigenetic tests (DNTs) represent an important evolution toward the personalized medicine and it are expected to increase their relevance in the near future. Our study revealed that DNTs are common in Italy even if information provided by the companies are at variable extent of completeness, particularly about the genetic markers assayed and the methods used for risk calculation. Furthermore, the companies seems to agree only partially with the ESHG statements and recommendations.

DNT is one one of the instruments toward the practical application of personalized medicine, therefore, initial efforts made by companies should be considered of great interest. However, a more strict collaboration among scientists, regulatory bodies and private companies is

needed to define an agreement on scientific, ethical and legal aspects of direct-to-consumer nutrigenetic testing.

REFERENCES

1) Hum. Genet. Comm. 2003. Genes direct - Ensuring the effective oversight of genetic tests supplied directly to thepublic. London: Dep. Health.

2) McGuire AL, Diaz CM, Wang T, Hilsenbeck SG. Social networkers' attitudes toward direct-to consumer personal genome testing. Am J Bioeth 2009;9:3–10.

3) McGowan M, Lambrix M, Fishman J. Motivations and moral imperatives of early adopters of personal genome services. Presented at the Genetics and Ethics Conference, Village at Breckenridge Conference Center, Breckenridge, CO, July 24–25, 2009:13, 19.

4) Baird P. 2002. Identification of genetic susceptibility to common diseases: the case for regulation. Perspect. Biol. Med. 45:516–28.

5) Haga S, Khoury MJ, Burke W. 2003. Genomic profiling to promote a healthy lifestyle: not ready for prime-time. Nat. Genet. 34:347–50.

6) Janssens CAJW, Carolina Pardo M, Steyerberg EW, van Duijn CM. 2004. Revisiting the clinical validity of multiplex genetic testing in complex diseases. Am. J. Hum. Genet. 74:585–588.

7) Offit K. 2008.Genomic profiles for disease risk: predictive or premature? J. Am. Med. Assoc. 299:1353–55.

8) Janssens AC, van Duijn CM. Genome-based prediction of common diseases: methodological considerations for future research. Genome Med. 2009 Feb 18;1(2):20.

9) Melanie Swan. Multigenic condition risk assessment in direct-to-consumer genomic services. Genetics In Medicine Volume 12, Number 5, May 2010.

10) Pauline C. Ng, Sarah S. Murray, Samuel Levy and J. Craig Venter. An agenda for personalized medicine, Nature 2009.

11) Direct-to-consumer genetic testing services: what are the medical benefits? Frebourg T. Eur J Hum Genet. 2012 Jan 4].

12) Statement of the ESHG on direct-to-consumer genetic testing for health-related purposes, European Journal of Human Genetics (2010).

13) Endorsement of ESHG "Statement on Direct-to-Consumer Genetic Testing for Health Purpose", SIGU, maggio 2010.

14) Paul Jaccard (1901). " Étude comparative de la distribution florale dans une portion des Alpes et des Jura". Bulletin de la Société Vaudoise des Sciences Naturelles 37, 547–579.

15) Sollid L M, Markussen G., EK J et al. Evidence for a primary association of coeliac disease to a particular HLA-DQ α/β heterodimer. J Exp Med 1989. 169345–350.350.

16) Sollid L M, Thorsby E. The primary association of coeliac disease to a given HLA-DQ α/β heterodimer explains the divergent HLA-DR association observed in various Caucasian populations.Tissue Antigens 1990. 36136–137.137.

17) Soria (1989) Proc Natl Acad Sci U S A 86, 587.

18) Ali M, Rellos P, Cox TM. Hereditary fructose intolerance. J Med Genet. 1998 May;35(5):353-65.

19) Lynn F. Cherkas, Juliette M. Harris, Elana Levinson et al. *"A Survey of UK Public Interest in Internet-Based Personal Genome Testing"*. PLoS ONE 2010.

20) K Grau, T Hansen, C Holst, et al. "Macronutrient-specific effect of FTO rs9939609 in response to a 10-week randomized hypo-energetic diet among obese Europeans", 2009.

21) K Grau, Stephane Cauchi, Claus Holst et al. "TCF7L2 rs7903146–macronutrient interaction in obese individuals' responses to a 10-wk randomized hypoenergetic diet", 2010 1–3.

22) ESHG European Society of Human Genetics. Genetic testing in asymptomatic minors:

Recommendations of the European Society of Human Genetics. Eur J Hum Genet. 2009 Jun;17(6):720-1.

TABLES

Table 1 Evaluation list

Quality lab certifications
Personal counseling provided
Statements about conflict of interests
Destiny of DNA samples
Information about who has access to personal data
Test on a minor

Table 2 DNTs companies

Company	Location	Website
Laboratorio Genoma	Roma	www.laboratoriogenoma.eu
Kriagen-Krian	Quartu	www.kriagen.it
Laboratorio De Sanctis	Roma	www.nutrigene.it
Planet	Milano	www.vitalybra.com
G&Life	Trieste	www.glifeprogram.com

Table 3 DNTs service characteristics

Company	**G&Life**		**De Sanctis**	**Genoma**	**Planet**	**Kriagen**	**Oxi.Gen**
DNT	**G-profile Nutrigenetics**	**G-diet Lifeplan**	**Test Nutrigene**	**Genoma DNT**	**Vitalybra**	**Kriagen DNT**	**Nutrisalus.Gen**
Costs (€)	384	744	200	840	230	320	600
Number of genes	20	20	14+UNK*	37	7	2*	19+UNK**
Number of SNPs	UNK	UNK	14	53	9	UNK	UNK
Studies for SNPs selection	NO	NO	YES	YES	NO	NO	NO
SNPs selection criteria	UNK	UNK	UNK	UNK	UNK	UNK	UNK
Personalized nutritional advices/plans	ADVICES	PLAN	ADVICES	NO***	ADVICES	NO****	ADVICES
Personalized nutritional advices/plans methods	UNK	UNK	UNK	UNK	UNK	UNK	UNK

*It was not specified the genes tested for celiac disease
** It was not specified the genes tested for interleukin panel and a further gene was untraceable
*** The dietary plan is provided only to customers that go to dietary practitioner paying an additional cost
**** The nutritional advices is provided only upon request

Table 4 Analyzed SNPs for tested genes

Genes	G&Life DNTs*	Genoma DNT	Test Nutrigene	Nutrisalus.Gen	Kriagen DNT	Vitalybra
ACE	?		1	?		
ACT		1				
ADH1C			1			
ADRA2B		1				
ADRB1		1				
ADRB2		2				
ADRB3		1				
ALDOB				?	1	
APOA1		1				1
APOA5	?					
APOB		1		?		
APOC3		2	1			
APOE		2		?		
CAT				?		
CBS		2				
CETP		2		?		
CHRNA3	?					
COL1A1		1		?		
CTR		1		?		
CYP1A2		3	1			1
ENOS				?		
ESR1	?	2		?		
FTO	?					1
GCKR	?					
GHRL	?					
GJA4		1				
GSTM1			1	?		
GSTP1		2		?		
GSTT1		1		?		
HMGCR		1				
IL10		1				
IL1B		1				
IL6		2	1			
LCT	?	1	1	?	1	
LDLR	?					
LEP	?					
LEPR	?					
LPL	?	1	1			
LRP5	?					
MC4R	?					
MMP3		1				
MnSOD		2	1	?		
MTHFR	?	2	1	2		1
MTR		1		?		
MTRR		1		?		
NAT2						2
NOS3		2				
NPY		1				
PGC1A	?					
PON1		1				
PPARA						1
PPARG	?	1	1			
RETN	?					
SLC6A4			1			
SOD3		1				
SREBF2		1				
TAS2R38	?					
TCF7L2	?					
TNFα		1	1			
VDR		3	1	?		2

* For both G&Life DNTs, G-diet Lifeplan and G-profile Nutrigenetics, are tested the same genes

Table 5 DNTs companies phenotypes (J1) and genes (J2) Jaccard Index

	Nutrisalus.Gen		**Vitalybra**		**Genoma DNT**		**Test Nutrigene**		**Kriagen DNT**	
	J1	J2	J1	J2	J1	J2	J1	J2	J1	J2
G&life DNTs	0.230	0.102	0.272	0.074	0.285	0.087	0.222	0.117	0.111	0.045
Nutrisalus.Gen			0.25	0.07	0.333	0.25	0.315	0.151	0.2	0.09
Vitalybra					0.307	0.09	0.235	0.142	0	0
Genoma DNT							0.35	0.196	0.090	0.025
Test Nutrigene									0.133	0.062

Table 6 DNTs Phenotypes

Primary lactose intolerance	12%
Moderate hyperhomocysteinemia	11%
Dyslypedemia	11%
Detoxification	10%
Osteoporosis	8%
Obesity and type 2 diabetes	8%
Inflammatory response	6%
Hypertension	4%
Bitter/sweet taste	4%
Nicotine dependence	4%
Anaerobic Physical Activities	4%
Celiac disease	4%
Appetite levels	4%
Hereditary fructose intolerance	4%
Others	6.00%

Table 7 Agreement to ESHG statement

	G&Life DNTs	Test Nutrigene	Genoma DNT	Vitalybra	Kriagen DNT	Nutrisalus.Gen
Quality laboratory certifications	NO	NO	YES	NO	NO	YES
Personal consult provided	YES	NO	YES	NO	YES	YES
Statements about conflict of interests	NO	NO	NO	NO	NO	NO
Destiny of DNA samples	YES	NO	YES	NO	YES	NO
Information about who has access to personal data	YES	NO	YES	NO	YES	YES
Avoiding testing on a minor	NO	NO	NO	NO	NO	NO

FIGURES