








## ORIGINAL ARTICLE

# Genetic testing users in Italy and Germany: Health orientation, health-related habits, and psychological profile

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## Abstract

**Background:** Rapid advances in genomic knowledge and widespread access to the web contributed to the development of genetic services by private companies or medical laboratories. In the European landscape, though, there is not a single coherent regulatory approach to genetic testing (GT). The study aimed to investigate differences and similarities between two populations of GT users, Italians and Germans, in terms of health-related behaviors, psychological characteristics, and attitudes toward genetic information.

**Methods:** Ninety-nine Italian GT users from one private genetic company and 64 Germans GT users from one medical laboratory, completed an ad hoc self-administered questionnaire.

**Results:** Results showed significant differences in health-related behaviors (unhealthy eating behaviors, smoking behaviors, and frequency in medical check-ups), with Germans reporting higher levels of unhealthy eating habits and smoking behaviors than Italians; Italian users also were more medically controlled. Furthermore, German participants were less willing to change their lifestyle following the GT results compared to Italian participants. Regarding psychological variables, German users felt more confident about their physical well-being and they seemed more motivated than Italians to avoid becoming unhealthy. Finally, two samples differed in the way they accessed genetic testing (with the Italians guided predominately by a physician in contrast with the Germans who were recommended by friends) and managed genetic testing results (with Italian participants significantly more willing to share results with doctors than German participants, who preferred sharing with the family).

**Conclusion:** The analysis of cultural and organizational differences could help in defining adequate guidelines for counseling, and provide inputs for regulators in different European contexts.

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## KEYWORDS

genetic testing, genetic testing users, health-related habits, psychological profile

## 1 | INTRODUCTION

Rapid advances in genomic knowledge and widespread access to the web contributed to the development of genetic services by private companies (Hoxhaj et al., 2020). In the last decades, genetic testing (GT) has become widespread in the US and Europe, allowing people to learn about their genetic risk or the presence of genetic variants that could pass the disease risk to their offspring (Oliveri, Marton, et al., 2020). Consumers can order GT directly on the company's website, often without the involvement of a medical practitioner, and receive genetic information related to their ancestry or their personal susceptibility to complex common diseases, such as diabetes, cardiovascular disease, or cancer (Hoxhaj et al., 2020). But the diversity of the services now offered by the online genomic companies does not make it possible to reduce the phenomenon to the concept of Direct to Consumer- GT, in which the common factor is that GT is offered, ordered and results are received by the users directly from the company (Roberts & Ostergren, 2013). Nowadays, as suggested by Prainsack and Vayena (2013), it could be appropriate to refer to such phenomenon using the expression Beyond-The-Clinic (BTC) genomics to label a cluster of different practices, services, and various forms of interaction between services providers, users, and medical practitioners.

Referring to the European landscape, there is not a single coherent regulatory approach to BTC genetic testing, but each country regulates the use of genetic testing independently (Kalokairinou et al., 2018). Specifically, Germany's legislation established that genetic testing can only be performed by a doctor after providing sufficient information and appropriate genetic counseling, while in Italy there is a more general authorization and guidelines depending on the type of testing (Kalokairinou et al., 2018; Oliveri, Marton, et al., 2020). In particular, in Italy and in Germany, depending on the nature of genetic test performed (Italy: Pre-symptomatic GT and Susceptibility GT; Germany: GT for health purposes), medical supervision is mandatory and there are restrictions in the way such services must be provided (Kalokairinou et al., 2018). For instance, the guidelines demand genetic counseling when the following GT are carried out: GT for health purposes or family reunification in Italy; predictive or prenatal GT, fetal aneuploidy risk assessment by non-invasive measures, and diagnostic GT in Germany (Kalokairinou et al., 2018).

On this topic, the experts were divided between those who were in favor of the complete freedom of laypeople to decide to purchase a genetic service based on their personal needs and those who instead considered it essential to evaluate case by case whether to submit a person to a genetic analysis or not (Oliveri, Marton, et al., 2020). In the EU states, among which Italy and Germany, emerged a lack of educational outreach about genomics to general citizens, to physicians and health professionals, the latter in particular appeared not sufficiently trained to apply genomics to clinical practice (Calabrò et al., 2021; Marzuillo et al., 2014; Mannocci et al., 2012; Mazzucco et al. 2012, 2017; Schmidtke et al., 2006). Mazzucco et al. (2017) also indicated the need for advertisements on billboards, TV, radio, etc., to inform general citizens about genomics and about the scope for genetic screening services.

Although BTC genetic testing is not equally regulated around the world, their interest and availability on websites has increased significantly, transforming genetic testing into products with the mainstream appeal (McGrath et al., 2019). Beyond the official guideline, a fundamental aspect to investigate, in order to regulate genetics services, is the way and intention people approach such kinds of services.

In literature, it is reported that laypeople perceive GT as very useful for disease prevention, health improvement, and for creating a better future plan for themselves and their children, even if they are simultaneously concerned about the possible detection of a genetic variant that could affect their life planning (Koeller et al., 2017; Oliveri, Masiero, et al., 2016; Wöhlke et al., 2019). Studies conducted on Italian and German users reported that the Italians had a greater perception of controllability of a genetic predisposition (e.g., through the adoption of preventive measures) compared to the Germans who perceived the genetic information as deterministic (Oliveri, Durosini, et al., 2020; Wöhlke et al., 2020). Regarding the GT clinical utility, users could be motivated to change lifestyles based on test results (Koeller et al., 2017). Large companies, such as 23andMe or Navigenics, promoted their services on their websites by advertising that knowing genetic make-up meant being able to make more informed health decisions and personalize lifestyle choices (Caulfield & McGuire, 2012). A recent systematic review and meta-analysis of 19 studies, conducted mainly in the United States, showed that GT users are more likely to improve their lifestyle, follow a healthier diet, increase

exercise and medical preventive checks, and quit smoking (Stewart et al., 2018). Similar results were found in a very recent Italian study (Oliveri et al., 2021), where GT users reported high motivation to change health-related habits reducing risky conditions, following a healthier diet, practicing more exercise, and improving medical preventive checks specifically (Oliveri et al., 2021; Oliveri, Marton, et al., 2020).

Another critical aspect concerning the access to GT services is the psychological impact that genetic risk communication could have on the clients of private companies. Data from a 2015 review seemed to confirm the perplexities expressed by some experts: they highlighted that people tended to be psychologically unprepared for genetic bad news and had negative emotional reactions after the results depending on the genetic test performed (Covolo et al., 2015). Other recent reviews concluded that evident negative impacts have not been found in the vast majority of the studied populations (Oliveri et al., 2018; Parens & Appelbaum, 2019; Roberts et al., 2017). In particular, Italian people tended to be confident in their ability to cope with genetic risk and tended to consider genetic tests as a valuable information to make important preventive decisions for themselves and their families (Oliveri et al., 2018), and overall GT outcomes resulted not to be harmful from a psychological point of view (Oliveri, Durosini, et al., 2020; Oliveri et al., 2016, 2018). A recent study conducted on the Italian GT users tried to depict their personal tendencies toward their own health and revealed that they have a very high motivation to avoid risky conditions that could affect their health, they do not like to take very high risks (e.g., the risk of taking a disease), and they define themselves neither optimistic or pessimistic about the possibility of future negative life events (Oliveri, Durosini, et al., 2020).

As reported by Oliveri and colleagues (2016), Italian and German laypeople showed interest in using BTC genetic testing, if mediated by a health care professional who could help in interpreting the results. The interest in purchasing GTs has been variable among the general population in Germany and Italy over the years (Hoxhaj et al., 2020), with the lower-educated German citizens showing higher interest. At the same time, German laypeople showed higher criticism toward health-related—disease susceptibility genetic testing, with a general lack of trust in private GT companies (Schaper et al., 2019) and a major concern regarding privacy and data management (Wöhlke et al., 2019).

Given the interesting country-specific differences that emerged from the study of Wöhlke et al. (2019), we aimed to delve into similarities and differences between these two European populations of GT users, with respect to users' health orientation, health-related habits, and psychological characteristics.

## 2 | MATERIALS AND METHODS

### 2.1 | Participants

A total of 163 adults were involved in this study and individually filled out the questionnaire (Nationality: *Italian* = 99, 60.74%; *German* = 64, 39.26%). Italian participants (Gender: *Female* = 87, 87.87%; *Male* = 12, 12.12%) ranged from 18 to 68 years old ( $M_{age} = 42.95$ ;  $SD = 11.31$ ). German participants (Gender: *Female* = 28, 43.75%; *Male* = 36, 56.25) ranged from 18 to 76 years old ( $M_{age} = 48.09$ ;  $SD = 15.66$ ). T-tests showed a significant difference between German and Italian participants regarding age ( $t(104.976) = 2.670$ ,  $p = .009$ ), with the German sample being older than the Italian one. Respondents were characterized by different professional qualifications, but the majority were employees (44.8%), or self-employed (27.6%). Participants underwent different types of genetic testing; in particular, the majority underwent Nutrigenetic Testing (42.9%), Personal Genomic Services (PGS— a complete panel of genetic screening for nutrition, pharmacogenomic and disease-related susceptibility; 24.5%), Genetic Testing for Cancer Risk (14.1%), Pharmacogenetics Testing (9.2%), Carrier Testing (2.5%) and Predisposition Testing (1.8%).

Regarding participants' health condition, 46.9% of German participants had suffered from specific illnesses in the past, as well as 30.3% of Italian participants. At the moment of testing, 45.3% of the German sample and 37.4% of the Italian sample were currently suffering from specific physical disease. In relation to genetic disease, only 15.6% of German participants reported a family history of genetically/inherited diseases (42.2% did not have enough information), in contrast with 27.3% of Italian participants (36.4% did not have enough information). Socio-demographic characteristics of the Italian and German participants are described in Table 1.

### 2.2 | Procedures

As mentioned above, the German sample was recruited via bio.logis (ZfH) in Frankfurt (Main), a clinical institute which provides a web-portal designed to give users direct access to selected categories of genetic information: pre- and postnatal genetic diagnostics, pharmacogenetics, carrier status for recessively inherited diseases, preventive targets and genetic counseling. Clients may log in to their personal account and see the current status of genetic analyses and results as well as news and updates provided by bio.logis (ZfH)<sup>1</sup>. Users were contacted via an internal email system of the bio.logis (ZfH)

TABLE 1 Sociodemographic data

Variables	Italy	Germany
	N (%)	N (%)
Participants	99 (60.73)	64 (39.27)
Male	12 (12.1)	36 (56.3)
Female	87 (87.9)	28 (43.8)
Marital status		
Single	13 (13.1)	9 (14.1)
Life-partnership	7 (7.1)	17 (26.6)
Married	76 (76.8)	34 (53.1)
Divorced	1 (1)	3 (4.7)
Widowed	2 (2)	1 (1.6)
Children		
Yes	47 (48.5)	32 (50)
No	50 (51.5)	32 (50)
Education		
Primary and secondary school	3 (3)	/ (0)
High school	44 (44.4)	28 (44.4)
Bachelor/master degree	41 (41.4)	22 (34.9)
Doctoral or postdoctoral	11 (11.2)	13 (20.6)

portal. The survey data were then collected online using the survey tool EvaSys.

The Italian sample was recruited via GenomaLab—Molecular Genetics Laboratory (headquarters in Rome and Milan), a private genetic company providing a wide range of panels of genetic analysis for disease susceptibility (e.g., predisposition to breast and colon cancer or cardiovascular disease), nutrigenetic, noninvasive prenatal testing pharmacogenetics and carrier status for recessively inherited diseases<sup>2</sup>. GenomaLab provides their clients with a focused and personalized counseling before testing. Users were contacted via an internal email system and invited to participate in the study. The link to the questionnaire was sent to the clients 2 weeks after they had received their genetic results.

Clients who required genetic testing during pregnancy or for medically assisted procreation (MAP; Prenatal Safe, Prenatal Screen, Preimplantation genetic diagnosis, etc.) were excluded since they were enrolled in a dedicated study. All participants signed informed consent and filled in the questionnaire through the Survey Monkey website. The recruitment started in February 2017 and ended in September 2017.

The research protocol was approved by the Institutional Review Board of the University of Milan, the principal coordination center of the survey, and by the Centre for Research Ethics and Bioethics, University of Uppsala, coordinator of the Mind the Risk project (see funding declaration). The study was conducted according to the Helsinki declaration.

## 2.3 | Measures

A structured and self-administered ad hoc questionnaire was created to assess the following domains.

- **Sociodemographic characteristics and health status:** participants were asked to provide their gender, age, educational level, marital status, parenthood, and current employment. Furthermore, they completed a set of five dichotomous questions designed to gather information on participants' health status, such as personal past and/or current physical diseases, familial disease, genetic disease history and mental disorders, through Yes or No answers. A sample item is "In your family history, is there a relevant experience of illness?"
- **Health-related behaviors:** a set of questions was developed in order to assess the daily health-related habits of participants. In particular were investigated:
  - The frequency in undergoing health screening behavior such as medical check-ups; participants were asked to answer a multiple choice question with the following alternatives: "Yes regularly" "When I have symptoms" "Sometimes", "Very rarely", "No, never".
  - Physical activity was investigated through the International Physical Activity Questionnaire-Short Form (IPAQ (Mannocci et al., 2012) AQ short-form includes three specific levels of intensity of physical activity: low (such as walking), moderate (such as at least 10 min of swimming or riding a bike), vigorous (such as at least 10 min of playing football or running). For each level of activity participants had to specify the frequency of occurrence, expressed in min per day/week. A total score for each participant was calculated following the Guidelines for Data Processing and the analysis of the IPAQ scores (Ipaq, 2005).
  - Smoking behaviors: participants were asked if they were smokers, former smokers, or no smokers.
  - Type of dietary regimen (vegan, vegetarian, and mediterranean) and the frequency of unhealthy food or drink intake (e.g., junk food, alcohol, etc.). For this last measure, participants were asked to indicate how often they had unhealthy dietary habits on a 5-point Likert scale, ranging from "never" (0) to "daily" (4). An overall score was calculated as the sum of the scores assigned to each unhealthy eating behavior, such as eating fried foods, drinking alcohol or soda (seven items). The higher the total score is, the higher the frequency of risky eating behaviors are.
- **Psychological dimensions**
  - **Health Orientation Scale (HOS):** The HOS is a self-report measure of several health-related personality



features, developed by Snell et al. (1991). Four subscale of the 10 included in the original version were used for this investigation, all composed of five items evaluated on a 5-point Likert scale (from 0 “Not at all characteristic of me” to 4 “Very characteristic of me”), that assessed four domains. (1) *Motivation to Avoid Unhealthiness (MAU)* referred to a high personal predisposition to avoid risky behaviors; (2) *Health Esteem and Confidence (HEC)* designed to measure positive thinking and optimism about health and physical status; (6) *Health Anxiety (HA)* designed to tap worry, discomfort and anxiety feelings that modulate one’s health perception; (7) *Health Expectations (HE)* that assessed people’s belief that their physical health will be excellent and positive in the future. A total score has been calculated for each subscale, that is the sum of each item’s score, ranging from 0 to 20.

- *Risk tolerance*: the Health and Retirement Study (Kimball et al., 2008) explores the risk tolerance using responses to hypothetical income gambles; risk tolerance is the amount of risk that one is comfortable taking or the degree of uncertainty that one is able to handle. Based on the responses to a scenario presented, individuals were assigned to four risk tolerance categories: “Very low risk tolerance” “Low-risk tolerance” “Medium-risk tolerance”, and “High risk tolerance”.

- **Attitude toward genetic testing**

- *Type, source of knowledge, decision on results sharing, and behavioral implication of GT*. Participants were asked to indicate the type of GT performed, how they became aware of the possibility of undergoing a genetic testing (through the doctor, relatives, friends, and acquaintances or by mass media), their intention to share test results with family members, physicians, or others and the implications of GT result for future health-related behaviors. In particular, they were asked if they had intention to change some health-related domains after receiving GT results, such as diet, physical activity, preventive screening behaviors, and smoking habits. A sample item is “Do you think your lifestyle will change after receiving the result of the genetic analysis?”

## 2.4 | Data analysis

Data analyses were performed using the statistical software analysis package SPSS (Version 26.0). In order to explore socio-demographic characteristics of both Italian and German samples and the overall individual tendencies of participants’ descriptive analysis were performed. After checking for assumptions, appropriate tests were

considered and chosen. Correlations were computed to test the association between variables. Contingency tables and chi-square tests were performed to make comparisons, based on country of origin, gender, and parenthood, in individual health-related behaviors, in the implication of GT result for future health-related behaviors, and in attitude toward genetic testing. Residual and expected values were calculated in order to verify if a specific group gave a significantly higher or lower rate of response (observed values) to certain items compared to the percentage expected and calculated according to the number of subjects recruited (expected values). In the interpretation of the standardized residuals, 1.96 was considered to be the discriminant value for a confidence level of 95%. Independent sample *t*-test and one-way analysis of variance (ANOVA) were also computed in order to assess possible differences between Italian and German participants in age levels, risky eating behavior, and in the intention to change health behaviors after GT. Further, MANOVA and regressions analyses were performed.

## 3 | RESULTS

### 3.1 | Health-related behaviors

There was a significant association between nationality and being current or former smokers ( $\chi^2(2) = 11.339$ ;  $p = .003$ ). Although Italian and German participants were mainly non-smokers (Italian: 56.7%; German: 51.6%), the Italian sample included a significant higher number of current smokers (19.6% Italians vs. 4.7% Germans), whereas German participants included a higher number of former smokers (43.8% Germans vs. 23.7% Italians). Regarding differences in the attitude to undergo health screening behavior such as medical checkups, results showed a significant association with the nationality ( $\chi^2(4) = 18.016$ ;  $p = .001$ ). Italians seem to undergo medical check-ups more regularly than Germans (62.6% Italians vs. 53% Germans), whereas 26.3% of Italians tended to undergo medical visits only when they have symptoms in contrast with 10.9% of Germans. More in general, Italian users seem to be more medically controlled. We investigated the link between nationality and the predominant type of diet. Pearson chi-square test showed a significant difference between Italian and German participants ( $\chi^2(2) = 7.442$ ;  $p = .024$ ) with German participants who were more frequently vegetarian than Italians (respectively 42.9% vs. 23.5%). Furthermore, *t*-tests showed a significant difference between countries regarding the mean scores in unhealthy eating behaviors ( $t(161) = 4.221$ ,  $p = .001$ ). Specifically, German participants reported higher levels of unhealthy eating habits ( $M = 8.97$ ,  $SD = 4.309$ ) than those

shown by Italian participants ( $M = 11.65$ ,  $SD = 3.710$ ). No statistically significant differences were found in the domain of physical activity between the two samples of participants ( $\chi^2(3) = 3.198$ ;  $p = .362$ ).

### 3.2 | Psychological characteristics and health orientation

Using Pillai's trace, multivariate analysis of variance revealed a significant effect of nationality on the Health Orientation Scale ( $V = .983$ ,  $F(4,157) = 2230.913$ ,  $p = .000$ ). In particular, Univariate ANOVAs revealed positive results for the dimension of Motivation to Avoid Unhealthiness ( $F(1160) = 6.563$ ,  $p = .011$ ) and for the dimension of Health Esteem and Confidence ( $F(1160) = 16.29$ ,  $p = .001$ ), with the German sample having significantly higher mean scores in both dependent variables (MAU: *Italians*:  $M: 17.56$ ;  $SD: 3.76$ ; *Germans*:  $M: 18.83$ ;  $SD: 2.99$ ; HEC: *Italians*:  $M: 15.64$ ;  $SD: 2.31$ ; *Germans*:  $M: 17.25$ ;  $SD: 2.8$ ). Furthermore, there was a significant interaction between provenience (Italian or German participants) and parenthood, on Motivation to Avoid Unhealthiness (MAU- $F(1156) = 3.630$ ,  $p < .05$ ). This effect indicates that Italian and German participants were affected differently by parenthood. Specifically, the motivation to avoid unhealthiness in Italian sample without children ( $M = 17.08$ ;  $SD = 3.45$ ) was significantly lower than those in German sample without children ( $M = 19.41$ ;  $SD = 2.88$ ).

To further test if HOS subscales may contribute to explain differences in health behaviors (physical activity, smoking, medical check), a multinomial logistic regression was employed. At the same time, a linear regression was used to assess how these predictors may have impacted unhealthy eating behaviors. In both cases, the predictors were not significant. The difference in levels of psychological dimension between Italians and Germans does not seem to explain the differences in health-related behaviors.

Furthermore,  $t$ -tests showed a non-significant difference between countries regarding the mean scores in risk tolerance levels (*Italians*:  $M: 2.27$ ;  $SD: 1.16$ ; *Germans*:  $M: 2.06$ ;  $SD: 1.13$ ;  $t(153) = 1.127$ ,  $p = .262$ ). Table 2 shows correlation between variables. Significant associations emerged between HOS subscales, and unhealthy eating behaviors. As expected, Unhealthy Eating Behaviors negatively correlates with MAU, but in the Italian sample only ( $r = -.274$ ;  $p < .01$ ).

### 3.3 | Attitude toward genetic testing information

Italians and Germans differ in the way they approach genetic testing ( $\chi^2(4) = 41.348$ ;  $p = .001$ ), with almost all

TABLE 2 Correlation coefficients for variables in the study

Variables	HOS_HA		HOS_HEC		HOS_MAU		HOS_HE		Risk tolerance	
	Italy	Germany	Italy	Germany	Italy	Germany	Italy	Germany	Italy	Germany
Risk tolerance	0.040	-0.183	-0.168	-0.060	-0.022	0.124	-0.028	0.093	—	—
Unhealthy eating behaviors	0.002	0.029	0.006	0.003	-0.274**	-0.011	0.184	-0.002	-0.141	0.201

\*\* $p < .01$

Italian sample (77.8%) that are directed to genetic testing by a physician in contrast with only 28.1% of the German, which subsequently comes to know genetic testing from friends or acquaintances (21.9%). Differences were evident also regarding the way they access and manage genetic testing result ( $\chi^2(3) = 29.767$ ;  $p = .001$ ). Specifically, German participants chose to access genetic results directly through genetic laboratory websites (75%) more often than Italian participants (35.4%), who instead prefer to use physicians as an intermediary (38.4%).

When asked about the way in which participants manage genetic information, and specifically with whom they intend to share the results, an interesting association emerges between nationality and the intention to share results with one's own family members ( $\chi^2(1) = 8.795$ ;  $p = .003$ ; see Figure 1). Considering the total sample, about half of participants (53.4%) preferred to not involve family members; specifically, 39.1% of Germans would not share the results with their family, while more than half of the Italian sample (62.9%) did not intend to share their test result with the family. The same association is noted between nationality and the intention to share genetic testing results with physicians ( $\chi^2(1) = 29.809$ ;  $p = .001$ ). Italian participants were significantly more willing to share results with doctors than German participants (83.5% vs. 42.2%).

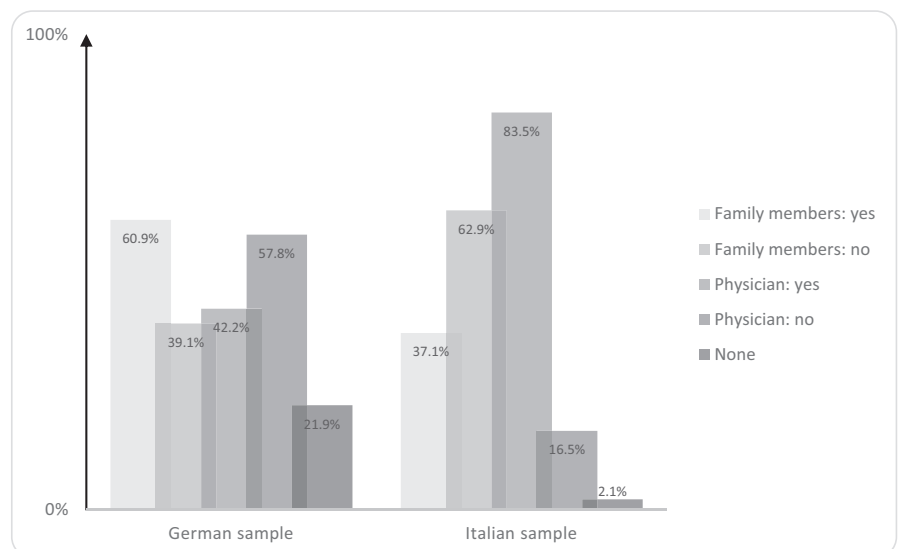
The intention to change lifestyle after genetic testing results differs in the two groups, with Germans being less willing to change lifestyle following the outcome of genetic testing than the Italians ( $\chi^2(1) = 32.010$ ;  $p = .001$ ). In particular, 75% of Germans do not intend to change their lifestyle after the result while, on the contrary, 70% of Italians would change their lifestyle. Specifically, 46.5% of Italians had the intention to improve diet-related behaviors; subsequently, they would be willing to increase preventive checks (32.3%) and exercise practices (31.3%),

while Germans would mainly intend to take vitamins or supplements (14%) or to improve their diet (10.9%).

## 4 | DISCUSSION

The advances in genomic knowledge and the rapid increase in the use of genetic testing in recent years make it paramount to outline characteristics of clients of laboratories in Europe, in order to understand if and how individual tendencies influence users' decisions regarding genetic risk information. In this study, we tried to compare profiles of GT users of two culturally different European population samples, German and Italian ones.

In the present study, and in line with previous studies (McGrath et al., 2019; Oliveri et al., 2021; Oliveri, Marton, et al., 2020; Roberts et al., 2017), the sample of Italian GT users was predominantly female, young adult, married, well-educated and without children. German GT users were divided fairly between men and women, with and without children, generally well-educated and predominantly married or in a stable relationship. Based on our results, the typical German GT user is older than the Italian one. As described in "Participants" section, both laboratories offer services that cover different health domains; the most required for both are nutrigenomics, pharmacogenomics, or susceptibility to cancer, but in particular, the German laboratory offers the PGS which includes a panel of genetics variants for only selected areas mentioned above. Concerning users' profile, several differences emerged comparing German and Italian GT users in health-related habits. As mentioned in the introduction, a recent review showed that GT users tend to follow a healthier diet, increase exercise and medical preventive checks, and quit smoking after testing (Koeller et al., 2017). Regarding lifestyle behaviors, German users were mostly



**FIGURE 1** Sharing attitude in Italian and German genetic testing consumers

non-smokers or former smokers, with eating habits more frequently unhealthy than Italians. In particular, although German respondents declared to follow mainly a vegetarian diet, they seem to adopt binge drinking or junk food consumption (etc.) more frequently than Italians. A recent analysis conducted by Behrens et al. (2018) reported that 9% of the German population declare high red meat consumption of  $\geq 500$  g/week, 96% of them eat processed meat (including hamburger/kebab, bratwurst/currywurst, sausage, and ham), 76% have a high salt intake of  $\geq 6$  g/day, 72% have a low dietary fiber intake ( $< 32$  g/day), and 71% does not consume enough fruit and non-starchy vegetables ( $< 400$  g/day). Another study showed huge disagreements in Germans consumers' viewpoints regarding what constitutes healthy nutrition (Yarar & Orth, 2018). The Italian population, instead, traditionally adhere to the Mediterranean diet, typically based on large quantities of vegetables, fruit, cereals, legumes, nuts, and limited amounts of animal products, the use of olive oil, rather than animal fat, for cooking (Pounis et al., 2017). Nevertheless, during the last 20 years, some food choices have changed in the opposite direction; in fact, the supply of vegetables and fruit has dropped, and the supply of tropical oils has increased (Vitale et al., 2021). Besides these different habits, there were also differences in the intention to change lifestyle after receiving GT results. In past studies that have investigated genetic testing users profiles, the decision to undergo genetic testing (e.g., nutrigenetics or predisposition to certain diseases such as cancer, where diet is important for prevention; Oliveri et al., 2019) was found to be closely linked to the intention to change certain behaviors such as dietary in particular, physical activity and frequency of medical check-ups (Horne et al., 2018; Oliveri et al., 2018, 2021; Stewart et al., 2018; Wolff et al., 2011). In the current study, the majority of Italian participants declared their intention to modify mainly dietary and exercise habits to tackle their risk or health condition after testing, while Germans participants seem to approach genetic testing without linking it to preventative behavior, confirming that they do not consider genetic testing strictly linked to decisions of such nature, for example, abandoning improper eating habits (Wöhlke et al., 2020). The cultural difference related to the perception of certainty vs. uncertainty linked to the nature of genetic risk information might have impacted the practical implication of GT results. As already showed in previous studies, Italian respondents tended not to consider the genetic risk as a "certainty" (deterministic) about their future health conditions, as seems to be the tendency of the Germans, but rather as a possibility to know and be able to actively manage their own risk (Wöhlke et al., 2020). In order to avoid that people pay and gather information that won't use (Gorini & Pravettoni, 2016), it is also important to early identify the intention that people

have to make specific health-related choices after GT, in order to support preventive decision-making and concrete implication of genetic risk information (Horne et al., 2018; Oliveri et al., 2021; Wolff et al., 2011).

The present study also showed that Italian GT users were referred to undergo regular medical checks more frequently than the Germans, who instead have a higher percentage of people who underwent medical visits sporadically. These data seem to delineate the tendency of the Italian GT consumers is not only to pay attention to prevention—or on the contrary to be worried for their health—but also to guide by their idea of being able to actively engage in their health (Oliveri, Marton, et al., 2020).

Why these differences between the Italian vs. German samples? Looking at the characteristics of respondents' personality traits it emerged that German users felt more positive and confident about their physical well-being and general psychophysical condition compared to Italian respondents, and felt already in control of their own health. People with higher levels of Health Esteem and Confidence are more likely to engage in protective behavior oriented to maximize health status (Geçkil & DüNDAR, 2011; Lowery et al., 2005). The Germans declared to be more motivated than the Italians to avoid being unhealthy, but other research suggest that this motivation does not directly translate into actual personal actions after GT (e.g., avoid unhealthy dietary behaviors; Oliveri et al., 2021; Oliveri, Masiero, et al., 2016).

Nevertheless, we should be cautious in interpreting these results, since control analysis performed in our study showed that such differences in the psychological health orientation do not directly explain the differences in German vs. Italian GT users behaviors. Based on linear and multinomial logistic regression results, we did not find a direct causal relationship between health orientation traits and actual health habits (such as smoking behaviors, medical check-up frequency, and unhealthy eating behaviors). Another interesting result instead showed that parenthood might be a factor influencing the motivation for undergoing GT and for avoiding unhealthiness. German participants with at least one child were declared to be higher motivated to avoid behaviors and activities which undermine physical health than Italian respondents (with children). The transition to parenthood is defined as a critical window for adult health, in particular in terms of psychosocial stress and health behavior changes (Ionio et al., 2019; Saxbe et al., 2018); for German GT users having children seems to be a motivational factor for avoiding unhealthy behavior.

In this investigation, German participants declared to prefer involving their family members and sharing genetic results, whereas Italian participants mainly preferred to share results with their referring physician, and only a small percentage would be willing to share results with their own



family. This is in contrast with what was found in the previous study conducted by Wöhlke et al. (2020), where instead a higher level of involvement of family members and sense of responsibility toward the family emerged in the Italian participants compared to German participants (such as a sort of moral obligation to share genetic information). In this study, Italian GT users assign a strong role to their referring physician, which is reflected both in the way they approach genetic testing and in the way they manage the result (Oliveri, Marton, et al., 2020). Germans seem to consider genetic information more personal, showing a sort of autonomy in the management of GT results and its implications (Oliveri et al., 2021; Oliveri, Masiero, et al., 2016). Literature also reported that the majority of Italian users are usually directed to GT by physicians (Oliveri et al., 2021), whereas German participants are often recommended by friends or acquaintances; even as regards access to results, the Germans seem to seek independence in the management of genetic information (Wöhlke et al., 2019). This aspect underlines the need to regulate modes of communication with clients, which could help them particularly when health professionals as intermediaries are not involved.

The present study has several limitations, related mainly to its explorative nature. The first limitation concerns the sample size. The sample size of both Italian and German groups is small and this compromises the opportunity to perform a country-specific subgroup analysis within each sample, as well as the generalizability of the results to a broader population. Future studies should compare health habits, psychological characteristics, and attitudes toward genetic information by differentiating users within and across countries according to the type of genetic testing performed, personal or family health history, age or gender, especially for the German population where data are missing. A second limitation concerns the prevalence of women in the sample, which limits the representativeness of the sample. Another limitation concerns the lack of information on the outcome of the genetic test; it could be useful assessing whether the genetic testing result changes the way genetic information is managed, as the way users decide to share the results. A longitudinal Italian study (Oliveri et al., 2021) evaluated this aspect in the Italian population; in order to compare users from different countries, future studies should investigate the implication of genetic test results (detected variants or not) on the attitude and intention to share the results.

In conclusion, the two samples of GT users show differences and similarities that should be taken into account by regulators, both in establishing policies and communication rules for the companies offering GT. As mentioned above there is not a single regulatory approach to BTC genetic testing in Europe, therefore cross-cultural investigation of the profile of companies and people who purchase

genetic testing through private laboratories in Europe should be promoted to regulate such services in a coherent manner. Furthermore, the analysis of cross-cultural and organizational differences could contribute to cluster GT users population in Europe for different communicative messages tailored to their needs and psychological aspects, to define adequate and efficient guidelines for genetic counseling, and to provide inputs for regulators in different European contexts.

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## CONFLICT OF INTERESTS

FS was employed by the company GenomaLab and DS was employed by the medical laboratories bio.logis. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## AUTHOR CONTRIBUTIONS

GO and SO contributed to the conception and the design of the work. SO, FS, DS, IC, and AG collected data. GO, EB, and CC analyzed and interpreted data. GO and EB drafted the work and CC and SO revised it critically. GP contributed with important intellectual content and supervised the whole process. GO confirmed that she had full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. All of the authors gave final approval of this version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## HUMAN STUDIES AND INFORMED CONSENT

In Germany, the protocol was approved by the 'University of Göttingen Human Research Review Committee'. In Italy, the research protocol was approved by the Ethical Committee of the University of Milan 08/14. All subjects gave consent to participation after reviewing the study information online. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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## ENDNOTES

<sup>1</sup> The User ID for access to the portal is provided directly to patients and to their doctors, who in the majority of cases were responsible for the referrals of patient's samples. A guest login to the genetic information services is available via <https://my.pgs-box.de>, username: MindtheriskStudy, password: UniMilano2021.

<sup>2</sup> <https://www.laboratorigenoma.eu>-a guest login to the services is available via <https://www.genomagroup.com/LoginRefertazione.aspx?ln=EN>, username: SurveyITA-G password GeneticInformation2019a)

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