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Public Knowledge of and Attitudes Toward Genetics and Genetic Testing

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Background: Variable health literacy and genetic knowledge may pose significant challenges to engaging the general public in personal genomics, specifically with respect to promoting risk comprehension and healthy behaviors. *Methods:* We are conducting a multistage study of individual responses to genomic risk information for Type 2 diabetes mellitus. A total of 300 individuals were recruited from the general public in Durham, North Carolina: 60% self-identified as White; 70% female; and 65% have a college degree. As part of the baseline survey, we assessed genetic knowledge and attitudes toward genetic testing. *Results:* Scores of factual knowledge of genetics ranged from 50% to 100% (average = 84%), with significant differences in relation to racial groups, the education level, and age. Scores were significantly higher on questions pertaining to the inheritance and causes of disease (mean score 90%) compared to scientific questions (mean score 77.4%). Scores on the knowledge survey were significantly higher than scores from European populations. Participants' perceived knowledge of the social consequences of genetic testing was significantly lower than their perceived knowledge of the medical uses of testing. More than half agreed with the statement that testing may affect a person's ability to obtain health insurance (51.3%) and 16% were worried about the consequences of testing for chances of finding a job. *Conclusions:* Despite the relatively high educational status and genetic knowledge of the study population, we find an imbalance of knowledge between scientific and medical concepts related to genetics as well as between the medical applications and societal consequences of testing, suggesting that more effort is needed to present the benefits, risks, and limitations of genetic testing, particularly, at the social and personal levels, to ensure informed decision making.

Introduction

Over the last decade, genetic testing has been transformed by an explosion of genomic data, powerful new technologies and analytical approaches (Zhao and Grant, 2011). Increasingly, risk information generated from a genome analysis for a range of conditions, such as heart disease, cancer, and Type 2 diabetes mellitus (T2DM), will inform disease prevention efforts (Bloss *et al.*, 2011; Chan and Ginsburg, 2011; Kingsmore and Saunders, 2011). Future promise notwithstanding, the current clinical utility (usefulness of information to improve health outcomes) of this information remains a subject of debate and appears to be a major obstacle to further translation or adoption (Hunter *et al.*, 2008; Rogowski *et al.*, 2009; Yang *et al.*, 2009; Khoury, 2010). However, even once demonstrated, true clinical utility cannot be achieved if patients/consumers are unable to correctly interpret and understand the significance of genomic risk information, either in the specific context of health care or for one's overall sense of personal well-being.

Studies suggest that health literacy may impact the understanding of personal genomic risk (Lea *et al.*, 2011). For example, it has been reported that women with lower health literacy recalled less information about a genetic test to predict breast cancer recurrence (although participants in these studies did not actually undergo genetic testing) (Lillie *et al.*, 2007; Brewer *et al.*, 2009). Likewise, genetic literacy can also affect public attitudes, interest, and understanding. Genetic literacy refers to one's knowledge and appreciation of basic genetic (and, in the modern context, genomic) principles, as they inform personal decision making and underlie effective participation in public debates on genetic or genomic issues

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(McInerney, 2002; Bowling *et al.*, 2008). Some studies have reported low levels of public understanding of genetic concepts (e.g., location of genes) and applications (e.g., newborn screening), although participants displayed familiarity with genetic terminology (Lanie *et al.*, 2004; Miller, 2004; Catz *et al.*, 2005; Lea *et al.*, 2011). In contrast, other studies have shown some public understanding of genetic concepts and genetics research, such as the meaning of a reported genetic association (Bates *et al.*, 2003; Miller, 2004; Levitt *et al.*, 2005). Longitudinal survey data suggest that awareness and understanding may be increasing (Miller, 2004; Singer *et al.*, 2008). The increased participation of the public in personal genomics activities, including research and direct-to-consumer genomic services (Eriksson *et al.*, 2010; Do *et al.*, 2011; Tung *et al.*, 2011) may be due, in part, to the public's increased awareness and understanding of genetics.

While strong factual knowledge of genetics seems likely to result in higher levels of comprehension of genomic risk, it is unclear whether this is an essential component for understanding risk and/or adopting healthy behavior (McBride *et al.*, 2010). We conducted a study to investigate the impact of genetic knowledge and other variables on comprehension and perception of genomic risk and on both intended and reported changes in one's health behaviors. In this report, we present data collected during the baseline survey characterizing participants' health literacy, genetic knowledge, and attitudes toward genetic testing.

Materials and Methods

Overall study design

We measured participants' health literacy, actual and perceived genetic knowledge and attitudes about genetic testing as part of the baseline assessment for a randomized clinical study. The overall goals of the randomized study were to explore the impact of health literacy, genetic knowledge, and the method of risk communication on risk comprehension and perception, and health behaviors in a community-based population for genomic risk of T2DM. Enrolled participants were required to (1) complete a pretest baseline screening for knowledge of and attitudes about genetics and genetic testing; (2) undergo genomic testing for risk of T2DM and (3) complete post-test follow-up assessments at intervals up to 6 months post-testing, to assess the comprehension and impact of knowledge of genomic risk on perceptions of risk and health behaviors (Fig. 1). This study was approved by the

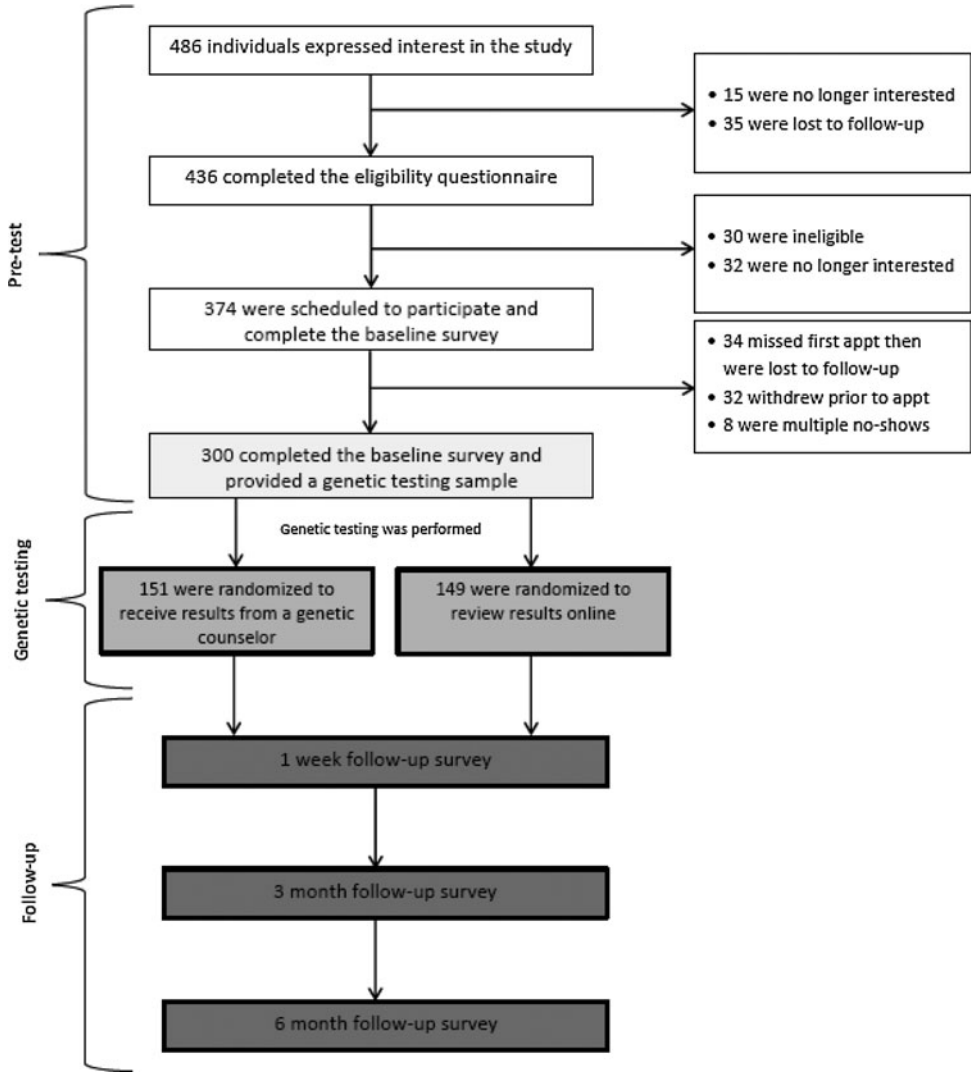

FIG. 1. Schematic of the study design.

Institutional Review Board of the Duke University Health System.

Participant recruitment

Participants for this study were recruited from Durham, NC through newspaper advertisements, flyers on the Duke University's campus and throughout the community, posters on public transit buses, and online advertisements. Eligible participants must have been at least 18 years of age, English-speaking, have Internet access, no personal history of T2DM, and not had a genetic test for T2DM.

Surveys

The baseline survey gathered information on participant demographics, health literacy, and genetic knowledge and attitudes about genetic testing. Although an instrument has been developed to assess literacy in a genetic context (Erby *et al.*, 2008), we decided to conduct separate assessments of health literacy and genetic knowledge to avoid any confounding between basic health literacy skills (including numeracy) with participants' actual or perceived knowledge of genetics. Numerous measures of health literacy in general and specific to disease populations, including T2DM, have been developed (Al Sayah *et al.*, 2012). We used the well-validated Short Test of Functional Health Literacy in Adults (S-TOFHLA) to measure health literacy (Parker *et al.*, 1995; Baker *et al.*, 1999). The test has been shown to have good reliability and validity compared to the other commonly used health literacy tool, the Rapid Estimate of Adult Literacy in Medicine (REALM) (Baker *et al.*, 1999). We used two validated instruments to assess actual and perceived genetic knowledge. A 16-item survey was used to measure actual knowledge about the association between genes, chromosomes, and cells and the body and diseases (Jallinoja and Aro, 1999). A second 11-item survey was used to assess perceived knowledge of medical possibilities and social consequences of genetic testing (Morren *et al.*, 2007).

To ascertain participants' attitudes and expectations about the future of genetic testing, we used a survey developed by Morren *et al.* (2007). In this survey, participants were asked to indicate their level of agreement with 13 statements regarding anticipation of the impact of genetic testing on society, use of genetic information, and the importance of genetic aspects of diseases. After completion of the baseline surveys, participants were provided educational resources about T2DM and genomics (NIH, 2006; NDIC, 2007).

Survey scoring

Overall health literacy scores (combined reading comprehension and numeracy scores) were categorized as inadequate (0–53), marginal (54–66), or adequate (67–100). Since only a single participant fell outside of the adequate functional health literacy range (score: 40), this variable was excluded from the statistical analysis. Perceived knowledge of genetics was scored as 1 = none; 2 = a little; 3 = a lot. Genetic attitudes (favorable (positive) and reserved (negative)) were scored on a 5-point scale (1 = totally disagree; 2 = disagree; 3 = don't know; 4 = agree; 5 = totally agree).

Survey analysis

In this article, we present data collected during the baseline survey characterizing participants' genetic knowledge and attitudes toward genetics. Descriptive statistics were used to summarize the demographic factors of the study sample and their association with baseline measures of knowledge. For each survey question, responses were compared to early reports (Jallinoja and Aro, 1999; Calsbeek *et al.*, 2007; Morren *et al.*, 2007) using Pearson chi-squared tests, with a Bonferonni correction for the number of questions in each measure of knowledge or attitudes. Kruskal–Wallis tests were used to evaluate the associations between the demographic factors and literacy and to compare subscales of literacy. Multivariate linear regression models for genetic knowledge were constructed from full models that included all participant characteristics with univariate $p < 0.2$, and then reduced in a step-down manner with Likelihood Ratio tests. Mean Score Chi-squared tests were used to evaluate different attitudes toward genetics among patient groups. Two-sided p-values are reported for all tests using a Type I error level of 0.05.

Results

Participant characteristics

Overall, 300 individuals were enrolled in the study (Fig. 1). Seventy percent of participants were female, 60% self-identified as White, and 65% reported a college degree or higher (Table 1). The number of participants with a college degree or higher is substantially higher than reported for the Durham region (40%), state of North Carolina (23.6%), and the U.S. (25%) (American Community Survey, 2005–2009). Forty-four

Table 1. Characteristics of Enrolled Participants ($N = 300$)

	N (%)
Sex	
Female	210 (70)
Race	
Black/African-American	86 (29)
White	179 (60)
Other	29 (9.7)
Prefer not to answer	4 (1.3)
Unsure	2 (0.7)
Age	
18–29 years old	131 (44)
30–39 years old	58 (19)
40–49 years old	48 (16)
50–59 years old	34 (11)
60–69 years old	28 (9)
70 years or older	1 (0.3)
Education	
Some high school or high-school graduate	29 (10)
Some college, but no degree or Associate's degree	74 (25)
Bachelors degree or higher	196 (65)
Missing response	1 (0.3)
Family history of T2DM	210 (70)
Annual household income	
Less than $20,000	65 (22)
$20,000 to $39,000	80 (27)
$40,000 to $49,000	38 (13)
$60,000 or more	99 (33)
Missing response	18 (6)

Table 2. General Knowledge of Genes and Disease (% of Participants Answering Questions Correctly)

	(General population)			(Patient population)	
	Current study population (n = 300)	*Jallinoja and Aro, 1999 [40] (n = 1216)*[a]	*p-Value*[b]	*Calsbeek et al., 2007 [39] (n = 306)*[c]	*p-Value*[b]
[Q1–Q11: Scientific facts]					
1. One can see a gene with a naked eye.	99	87	< 0.001	75	< 0.001
2. A gene is a disease.	98	87	< 0.001	71	< 0.001
3. A gene is a molecule that controls hereditary characteristics.	84	63	< 0.001	52	< 0.001
4. Genes are inside cells.	91	55	< 0.001	46	< 0.001
5. A gene is a piece of DNA.	93	57	< 0.001	42	< 0.001
6. A gene is a cell.	74	51	< 0.001	29	< 0.001
7. A gene is a part of a chromosome.	91	45	< 0.001	34	< 0.001
8. Different body parts include different genes.	67	36	< 0.001	23	< 0.001
9. Genes are bigger than chromosomes.	83	41	< 0.001	21	< 0.001
10. The genotype is not susceptible to human intervention.[d]	25	77	1.0	16	0.008
11. It has been estimated that a person has 22,000 genes.	60	18	< 0.001	8	< 0.001
Average subsection score	78.6	56.1	-	37.9	-
[Q12–Q16: Disease-related concepts]					
12. Healthy parents can have a child with a hereditary disease.	97	85	< 0.001	75	< 0.001
13. The onset of certain diseases is due to genes, environment, and lifestyle.	98	88	< 0.001	75	< 0.001
14. The carrier of a disease gene may be completely healthy.	95	83	< 0.001	66	< 0.001
15. All serious diseases are hereditary.	98	83	< 0.001	59	< 0.001
16. The child of a disease gene carrier is always also a carrier of the same disease gene.	85	60	< 0.001	41	< 0.001
Average subsection score	94.6	79.8	< 0.001	63.2	< 0.001
Overall average score	83.6	63.5	-	45.8	-

[a]Study population for Jallinoja and Aro (1999) consisted of 1,216 participants randomly selected from the general population in Finland.
[b]*p*-values for increased knowledge are computed under the Pearson's Chi-squared test with Yates' continuity correction.
[c]Study population for Calsbeek *et al.* (2007) consisted of 306 participants enrolled in the Panel of Patients with Chronic Diseases in the Netherlands and diagnosed with a chronic disease.
[d]The number of genes has changed for each survey to reflect current knowledge. Jallinoja and Aro (1999) originally listed 70,000 genes, Calsbeek *et al.* (2007) listed 30,000, and this survey listed 22,000.

percent of participants were between 20 to 29 years of age. Seventy percent indicated that they had a family history of T2DM. Comparatively, about 30% of the general U.S. population has a family history of T2DM (Valdez *et al.*, 2007).

Actual genetic knowledge

Scores of factual knowledge of genetics ranged from 50% to 100% (mean = 83.6%; median = 87.5%) (Table 2). Participants scored significantly higher on questions pertaining to the inheritance and causes of disease (mean score 94.6%) compared to questions on genes, chromosomes, and cells (mean score 78.6%) ($p < 0.0001$). No differences were noted between scores for scientific questions compared to inheritance-related questions with respect to respondent demographics. Overall differences in genetic knowledge scores were observed among the racial groups (4 df; $p = 0.0001$) with average scores of 13.7 (±1.4) in White and 12.8 (±1.8) in non-White participants. In addition, differences in genetic knowledge were observed among education levels (6 df; $p = 0.0001$) with increased genetic knowledge in participants with higher education levels (Spearman rho = 0.22) and among age groups (4 df; $p = 0.004$), with a slight downward trend with age deciles (Spearman rho = −0.17). In the multivariate model, the age, racial group, and education level remained statistically significant after adjusting for the other demographic factors, while no pairwise interactions were found to be significant (data not shown). No significant difference was observed in the genetic knowledge scores for participants who reported a family history of T2DM as compared to those who did not report a family history (1 df; $p = 0.2913$).

Perceived genetic knowledge

The majority of participants (79%) indicated that they had some knowledge (they answered either "a lot" or "a little") of the medical applications of genetics (Table 3). A significantly lower proportion (64%) reported having some knowledge of the social implications ($p < 0.0001$). However, despite their high education status, more participants indicated they knew nothing about the medical possibilities or social consequences of genetic testing than those who indicated they knew a lot.

Table 3. Perceived Genetic Knowledge of Participants (Percentage Response)

	A lot		*A little*		*None*	
	Current study	*Morren et al., 2007*[a]	*Current study*	*Morren et al., 2007*[a]	*Current study*	*Morren et al., 2007*[a]
Medical possibilities/uses of genetic testing						
1. The possibility of early detection of certain disorders using DNA-testing	18	17	68	47	14	36
2. The significance of DNA-testing for my relatives	15	12	64	32	21	56
3. The significance of DNA-testing for my offspring	19	12	63	30	18	58
4. The possibility to use genetic knowledge to prevent or treat a disorder	19	11	67	38	15	52
5. The possibilities and risks of gene therapy	11	6	51	24	38	70
Mean response for medical possibilities scale:	16	12	63	34	21	54
Social consequences						
6. Your rights to refuse DNA testing	32	8	49	18	19	74
7. The consequences of DNA testing for my daily life	17	7	54	17	29	76
8. The consequences of DNA testing for my work	15	6	40	14	45	79
9. The consequences of DNA testing for affecting health insurance	17	6	48	17	34	76
10. Your own possibilities to apply for a DNA test	15	5	46	18	39	77
11. The rights of third parties to inquire about the results of a DNA test	12	5	38	15	50	80
Mean response for social consequences scale:	18	6	46	16	36	*77*
Total mean response	17	9	54	25	28	*66*

[a]Study population consisted of 1,496 participants enrolled in the Panel of Patients with Chronic Diseases in the Netherlands and diagnosed with a chronic disease.

For example, 36% indicated they knew nothing about the social consequences of genetic testing. A higher proportion (45%) reported having no knowledge about the potential consequences of testing on their job and 50% reported having no knowledge about the rights of third parties to inquire about the results of a DNA test. No significant differences were noted between the overall perceived genetic knowledge with respect to respondent demographics. In comparison to a previous study (Morren *et al.*, 2007), a significantly larger proportion of our study population reported having some or a lot of knowledge of each possibility or issue.

Interest and attitudes toward genetics

When asked about their general interest in genetic testing, 52% of participants indicated they were somewhat interested in the topic of genetic testing and 45% indicated they were extremely interested. Most participants expressed positive attitudes toward the goals of genetics research and uses of genetic testing (Table 4). For example, 92% indicated that they agreed or strongly agreed with the use of DNA testing for early detection of diseases. Participants in our study had significantly more positive attitudes than those in the two European studies of patient populations that used the same survey instrument (Jallinoja and Aro, 1999; Calsbeek *et al.*, 2007) ($p < 0.003$).

Attitudes were mixed regarding the consequences of testing. More than half of the participants agreed with the possibility that a DNA test will change a person's future (56.3%) or affect a person's ability to obtain health insurance (51.3%), and 16% were worried about the consequences of testing for chances of finding a job. Less than 10% of the participants agreed with the statement that they would not want to know their risk for a certain disease (not specified) or an untreatable disease, with the greatest disparities in attitudes between our population and the two other European populations for these two questions ($p < 0.0001$). Five percent indicated that the idea of a DNA test frightens them, substantially fewer than reported in the studies of European populations. Overall, our population was less skeptical in their attitudes about testing than the European populations (17.87 ± 3.7, $p < 0.0001$) (data not shown).

Among study participants, males were more likely than females to believe that DNA research is hopeful for treatment of diseases ($p = 0.0408$) and that the development of DNA research represents a positive medical progress (0.0511). Participants who self-reported as White ($p = 0.0004$), as well as those who have a higher education status ($p = 0.0431$), were more likely to believe that the possibility of a DNA test will change a person's future. Younger individuals were more likely to indicate that they worried about the consequences of DNA testing for finding a job ($p = 0.0082$). We did not observe any association between genetic knowledge and positive attitudes. However, participants with higher genetic knowledge ($\geq 87.5\%$) were more likely to express uncertainty about the impact of genetic testing on a person's future than those with a lower level of genetic knowledge ($p = 0.02$) and also more likely to agree with the statement that DNA testing is frightening ($p = 0.04$).

Table 4. Attitudes Toward Genetics Research and Testing

	% Strongly agree/agree	Mean score[a]
Favorable attitudes		
1. I think the development of DNA research is hopeful for the treatment of diseases.	93.3	4.4
2. I think that the development of DNA research is a positive medical progress.	93.7	4.5
3. I approve of using DNA-testing for early detection of diseases.	91.7	4.4
4. I would inform my children about the results of a DNA-test for a specific disease.	76.3	4.1
5. I want to know whether my disease is hereditary.	94.3	4.5
6. I would inform my siblings about the results of a DNA-test for a specific disease.	89.7	4.4
Reserved attitudes		
7. I worry about the consequences of DNA-testing for being able to affect health insurance.	51.3	3.4
8. The possibility of a DNA-test will change one's future.	56.3	3.6
9. As long as a disease cannot be treated, I don't want a DNA-test.	7.3	2.1
10. If I had a DNA-test done, my family does not need to know about the result.	22.7	2.6
11. I don't want a DNA-test to tell me that I am at risk for a certain disease.	7.7	2.0
12. I worry about the consequences of DNA-testing for the chances of finding a job.	15.7	2.4
13. The idea of a DNA-test frightens me.	5.3	1.7

[a]Mean Score (items were answered on a 5-point scale: 1 = totally disagree to 5 = totally agree).

Discussion

The adoption of personalized medicine will be driven, in part, by the public's understanding and interest in new clinical genetic applications (Syurina *et al.*, 2011). However, this area has been understudied with respect to the association of genetic knowledge, attitudes about genetic testing, actual comprehension of personal genomic risks and its impact on health behaviors. In this article, we describe genetic knowledge and baseline attitudes toward genetic testing of participants enrolled in a study investigating the impact of genomic risk testing for T2DM on comprehension of personal genomic risk and behavior change. In summary, our U.S.-based study population demonstrated high genetic knowledge and positive attitudes about genetic research and testing, although knowledge of potential consequences of genetic testing varied.

Overall, participants demonstrated higher scores than published reports on European populations using the same survey instruments in a patient (Calsbeek *et al.*, 2007) and general public population (Jallinoja and Aro, 1999). The demographics of each of the survey study populations varied with respect to gender, age, and education status (race was not a variable in the European studies). However, our study as well as the two European studies (Jallinoja and Aro, 1999; Calsbeek *et al.*, 2007) reported similar associations between age, education, and genetic knowledge. Cultural differences may account for disparities in knowledge as well as differing perceptions of the role of genes in disease, and national differences between the U.S. and Europe in science education curricula, and health systems.

The higher knowledge levels in our study may also be due to increased reporting of genetic and genomic research in recent years and the permeation of genetics into our culture, resulting in greater public familiarity (Bates, 2005). However, some studies suggest that public familiarity does not necessarily correlate with understanding (Morris and Adley, 2001; Lanie *et al.*, 2004). The illusion of knowing or perceived comprehension of a specific term or concept due to widespread media reporting may create a false sense of reassurance that will inhibit individuals from further seeking information (Glenberg *et al.*, 1982; Park, 2001). Even if individuals could accurately define terms or describe scientific concepts, translating basic knowledge to decisions regarding a genetic test may not be possible (Lanie *et al.*, 2004).

Study participants demonstrated a greater knowledge of genetic disease-related concepts than scientific facts, consistent with published findings (Jallinoja and Aro, 1999; Calsbeek *et al.*, 2007; Smerecnik *et al.*, 2008; Condit, 2010). Despite their knowledge of the medical applications of genetics, one third of participants indicated they had no knowledge of some of the adverse societal consequences of testing. This inconsistency may be due to biased reporting of the benefits of genetics research for medical applications in the news compared to potential harms. Similarly, other articles have reported that less than half of the survey populations of the public (Allain *et al.*, 2012) and health professionals (Laedtke *et al.*, 2012) were aware of the existing federal legislation (GINA) protecting against the use of genetic information by health insurers and employers. Before the passage of the federal legislation prohibiting genetic discrimination, individuals often cited this issue as a primary concern and/or reason not to have genetic testing (Lapham *et al.*, 1996; Hadley *et al.*, 2003; Apse *et al.*, 2004; Hall *et al.*, 2005). Therefore, the lower perceived knowledge of the social consequences, and potentially of existing protections, remains a concern as some individuals may not be making informed decisions regarding clinical uses of genetic or genomic testing. Efforts are needed to educate clinicians about some of these issues, so that they may appropriately inform their patients in addition to the risks and benefits of testing.

Participants in our study also had significantly more positive attitudes than the two European patient study populations (Jallinoja and Aro, 1999; Calsbeek *et al.*, 2007). The more negative attitudes of the European study populations may be attributed to national attitudes toward biotechnology, genetic testing, and genetically modified foods

(Davison *et al.*, 1997; Gaskell *et al.*, 1999; Bonfadelli, 2005). Although higher knowledge has been associated with positive attitudes toward genetic testing (Davison *et al.*, 1997; Rose *et al.*, 2005), we found little or no relationship between knowledge and attitudes, comporting with other published findings (Macnicol *et al.*, 1991; Singer, 1991; Decruyenaere *et al.*, 1992). We observed an inverse correlation to a small degree with some of the more negative attitudes toward testing also reported elsewhere (Jallinoja and Aro, 2000). These results may not be surprising for participants enrolled in a genetic testing study, but remain consistent with previous reports of the public's knowledge and attitudes toward genetics.

Some limitations of our findings should be noted. Although our population included a substantial proportion of African-Americans and other minorities, it was relatively young and highly educated. However, the make-up of our study population is similar to other reported studies of early adopters of genomic technologies (McGuire *et al.*, 2009; Bloss *et al.*, 2011) and participants of clinical studies on personalized genomic risk (Gollust *et al.*, 2012). As a result of the high education status, we were unable to assess the association with health literacy and may have had a more limited range of genetic knowledge and attitudes. The high levels of genetic knowledge and positive attitudes may also be attributed to the participants' interest/willingness to participate in a study about genetic testing and therefore, may not be representative of the general population. The high rate of family history of T2DM may also have served as a motivator for participation and biasing responses. However, this may also be considered a strength of the study, since this is a population who may represent patient populations likely to have T2DM testing. The administration of the surveys (i.e., the order of the surveys, the knowledge surveys came before the attitudes surveys) may also have affected participant responses. Given these limitations, further research is needed to fully inform the development of educational and health interventions designed to enhance genetic health decision making.

This study provides insight regarding the imbalance of knowledge between scientific and medical concepts related to genetics as well as between the medical applications and social consequences of testing. Our finding of different levels of knowledge regarding scientific concepts and medical uses or societal implications of genomic testing may affect the study participants' ability to comprehend genomic risk information and potentially bias behavior outcomes, particularly if they value their personal genomic risk information differently. The association of genetic knowledge with race and education may also impact behavior outcomes as these characteristics may be linked to knowledge about healthy lifestyles and economic feasibility.

Although it is still unclear what level of knowledge of genetics is needed or desired to ensure informed decision making and optimize the understanding of genomic risk, the biased knowledge suggests that more effort is needed to present the benefits, risks, and limitations of genetic testing to ensure informed decision making, both in the context of health care and in terms of one's overall sense of personal well-being and social identity. Our follow-up reports will explore the relationship between genetic knowledge, associated factors like race and education, and delivery models of risk information on comprehension and behavior, providing further insight about what level of knowledge patients/consumers should be equipped with to optimize their understanding and test utility.

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Author Disclosure Statement

No competing financial interests exist.

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