Awareness, Knowledge and Perception of DNA Analysis among Residents of Benin City, Edo state, Nigeria

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Abstract

Several studies have shown the various applications of DNA analysis in fields like forensic sciences and medicine. In Nigeria, a fair percentage of the human population have little awareness, knowledge and perception of this technology. This study therefore aimed at assessing the level of awareness, knowledge and perception of DNA analysis among Benin City residents. A total of 100 residents participated in this study. They are males (n = 50) and females (n = 50) of various Nigerian tribes with different occupational and educational levels, aged above 21years residing in Benin City. A structured and segmented questionnaire was used to obtain demographical information of the participants as well as their consents. Results revealed fairly high awareness and knowledge of DNA testing amongst residents of Benin City. Perception towards DNA analysis was generally positive; However, negative awareness were evident in whether DNA is a living thing, where it can be found, whether DNA can be destroyed, carrying out medical test as a result of crime, knowing any outfits that analyze DNA in Benin City and use of DNA technology to unravel crime. Also of concern is false high knowledge that DNA technology can be used to select spouse and lack of knowledge on the importance of DNA testing in natural disaster to identify victims. But surprisingly, high positivity response was recorded on participants' expectation that government should establish more DNA analysis centres through legislation and general perception of DNA analysis respectively. Conclusively, the awareness, knowledge and perception of the participants on DNA analysis in this study are fairly high.

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Introduction

Forensic DNA testing has become a significant resource for criminal investigation and prosecution activities in criminal justice systems throughout the world (Ge *et al.,* 2014*;* Gill *et al.,* 2019*;* Jakovski *et al.,* 2017; Hindmarsh and Prainsack, 2010). Forensic DNA testing can be conducted in several ways: first, by comparing the DNA profiles from criminal suspects to DNA evidence, to assess the likelihood of their involvement in a crime. The second kind of use is related to searching for a link between the biological materials collected from a crime scene to a DNA profile stored in a criminal DNA database. The third form of forensic DNA testing is related to procedures to search for criminal suspects through their connection with biological relatives. Finally, the inference of human externally visible physical features from a biological sample collected at the crime scene (Wienroth *et al.,* 2014; Toom, 2018). Other areas of importance of DNA analysis include; identification of individuals during natural disasters and settling paternity and maternity disputes. Also of clinical importance are; prediction of future diseases through the diagnosis of inherited disorders and human diseases, assessment of donor hematopoietic engraftment after bone marrow transplantation, chimerism analysis after solid organ transplantation, confirming a diagnosis of hydratid form mole, and resolving issues of specimen identity in cases of specimen mislabeling or misidentification, evaluation of tumor transmission after transplantation and thus determine whether malignancy is of a donor or recipient origin (Saad, 2005).

The techniques that are applied in identity testing are DNA fingerprinting, DNA profiling, and DNA typing.

These terms are used interchangeably even if there exist some technical differences between the tests. Types of DNA typing include polymerase chain reaction (PCR), short tandem repeat (STR) analysis, Y- chromosome analysis, refraction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), and mitochondrial DNA analysis (National Institute of Justice, 2012). Some samples that can be used for DNA analysis are liquid blood or dried blood stains, dried saliva or dry saliva stains, liquid semen or dry semen stains, hair, fingernail, skin tissue, and buccal swabs (National Institute of Justice, 2012).

Public attitudes towards genetic testing for the risk of diseases, including cancer, are generally positive (Etchegary, 2014); Henneman *et al.,* 2013; Haga *et al.,* 2013), but awareness, knowledge, and perception of the diagnostic technologies remain a concern especially in the area of DNA analysis in developing countries.

To the best of our knowledge, no research has been carried out on the awareness, knowledge, and perception of DNA analysis in Nigeria. Therefore, there is a paucity of information and literature in this area, hence the justification of this work.

Methodology

Study Area

This study was conducted in Benin City, Benin City is located in Edo State, Nigeria and it is located at 6.34 latitude and 5.63 longitudes. It is situated at an elevation of 88 meters above sea level. Benin City has a population of about 1,496,000 people, making it the biggest city in Edo State (NPC and ICF, 2014). It is located in the South-South region of Nigeria. It shares boundaries with Ondo State (West), Delta State (South), and Kogi State (North).

Study Population

A total of one hundred residents participated in this study (males (n = 50) and females (n = 50)). They are males and females of various Nigerian tribes of different occupations and educational levels, aged above 21years residing in Benin City. A structured and segmented questionnaire was used to obtain demographical information such as sex, age, marital status, occupation, religion, and level of education length of residency in Benin City. Informed consent was obtained from each participant after proper notification and information on the nature of the research, risks involved benefits as well as its confidentiality. The ethics and research committee of the Ministry of Environment, Benin City approved this work.

Data Collection

Research Instrument (Questionnaire): The study utilized a pre-tested 30 items questionnaire to obtain information about awareness, knowledge, and perception of DNA analysis in Benin City.

Pretest: The questionnaire was pre-tested in a sample (N = 20) of participants and the necessary adjustments were made to suit the study aims and objectives.

Section A – Demographics: This portion of the questionnaire obtained information on age, sex, marital status, occupation, level of education, length of residency in Benin City, and religion by the participants. Section B – Awareness and knowledge of DNA analysis: This part of the questionnaire was to determine the level of awareness and knowledge of DNA analysis. It was made up of 21 items with specific questions about awareness and knowledge of DNA testing technology, the meaning of DNA, the importance of DNA technology, the source of DNA, and knowledge of any facility in the locality that carries out DNA analysis. Awareness was measured in two ways either a dichotomous Yes/No question Gammon *et al.* (2017), Heck *et al*. (2008), Honda (2003), Huang *et al*. (2014), Kaplan *et al.* (2006), Pagan *et al*. (2009), Peters *et al*. (2004), Vadaparampil *et al*. (2006), Adams *et al*. (2015) or a measure asking participants how much they had heard/read.

Section C – Perception of DNA Analysis: This segment includes the general perception of the participants on DNA analysis technology.

Validity: A thorough review of the entire questionnaire was done by a senior researcher to ascertain its validity.

Statistical Analysis

Data were analyzed using statistical package for social sciences (SPSS) version 25. Descriptive statistics were used to analyze the distinct objectives of the study, and values were presented as frequency and percentages in tables and charts.

Results

Table 1 shows the demographic characteristics of the respondents that participated in the study, forty-five percent of them were male, and 55 (55%) were female. Forty percent of the respondents were between the age range of 21-30 years, followed by 35% between 31-40 years, 16% between 41-50 years, 8% were between 51-60 years, and 1% was greater than 60 years old. Marital status results showed that the majority of the respondents were married having 49%, followed by 46% being single, and widows had 5%. The majority of the respondents had tertiary education with 55%, secondary education 46% and 5% had postgraduate education. The majority of the respondents were students, civil servants, and traders with vocational activity 25% each, tailor and business, 5%, barbers, caterers, and mechanics had 2% each, while plumber, welder, technician, baker, computer programmer, transporter, hairstylist, medical personnel, and

electrician all had 1% each. The majority of the respondents were Christians with 98(98%), while Muslims were 2%.

Figure 1 shows the length of residency in Benin City among the respondents. Out of the 100 subjects, 42% said they have resided in Benin City for 21-30 years, 32% said 0-10 years, 13% said 31-40 years, 6% said 41-50 years, 5% said 11-20 years, and the least was 2% who had lived for 51-60 years.

Figure 2 shows the distributions of various ethnic groups among the residents of Benin City. Out of the 100 subjects that participate in the study, 42% are Edos 29% are Ibo, 14% are Yoruba, 11% are from Delta, 2% are Hausa, and 1% each is from Ijaw and Calabar.

Table 2 summary revealed that out of the 100 respondents that participated in the study, 89 (89%) of them said they have never been involved in the use of DNA analysis as a result of crime, 3(3%) said, they have been involved, while 8 (8%) said they were involved as a result of a dispute over parenthood. Ninety-four (94%) of the respondents said they were never involved in a medical test, and 6(6%) said they were involved in a medical test as a result of the crime. Fifty-three (53%) of the respondents have heard of forensic or DNA analysis, while 47(47%) never heard of DNA analysis, 71(71%) said no outfit in Benin City that can analyze DNA, and 29 (29%) knew of an outfit. Ninety-three percent 93(93%) of the respondents said they have not been to any outfit that analyzes DNA before, while 7(7%) said they have been to an outfit. Out of seven that had visited a DNA analysis laboratory, 4(57.1%) had been there for an inquiry, while 3(42.9%) for testing. Of the three respondents that have been to the DNA laboratory for testing, the blood sample was requested from 2(66.7%), while a buccal smear sample was requested from 1(33.3%)

Table 3 summary revealed that out of the 100 respondents that participated in the study, 55(55%) of the respondents said yes they know the full meaning of DNA, and 45(45%) said they don't know. The majority 51(51%), of the respondents, said they don't know if DNA is a living thing, followed by 26(26%), which said DNA is not a living thing, while 23(3%) said it is a living thing. The majority of the respondents said they don't know where they can find DNA 62(62%), while 38(3%) said DNA can be found everywhere. Forty-six 46(46%) of the respondents said they don't know that DNA can be destroyed, 14(14%) said it cannot be destroyed while 40(40%) said it can be destroyed. The majority 22(55%) of the respondents said fire can destroy DNA, 14(35%) chemical, while 3(7.5%) and 1(2.5%) respondents said water and sun can destroy DNA respectively. The majority 43(43.4%) of the respondents said that they don't know if blood is the only sample used for DNA analysis, 26(26.3%) said it is only blood while 30(30.3%) said it is not only blood. Fifty-eight 58(58%) of the respondents said yes that DNA can be used to unravel the crime, 6(6%) said no, while 36(36) don't know if DNA can be used to unravel the crime. Out of the 100 respondents, only 34 had a response to the kind of crimes that DNA analysis can be used to unravel, majority 21(61.8%) of the respondents said murder, rape 5(14.7%), robbery 4(11.8%), paternity and maternity dispute 2 (5.9%), and 1(2.9%) each for homicide and kidnap respectively. When the knowledge of the respondents was tested on whether DNA analysis can be carried out on a corpse no matter how long it was buried, ninety-nine responded. Of the ninety-nine, 45(45.5) said yes, 6(6.1) said no, while 48(48.5) did not know if DNA analysis can be done on the buried corpse.

Table 4 summary revealed that the majority of the respondents said that DNA testing can be used to select spouses 56(56%), 39(39%) don't know, while 5(5%) said no it cannot be used. The majority 52(52%) of the respondents said they don't know that DNA testing can be used to share deceased property followed in a way, 29(29%) said yes, while 19(19%) said no. When the knowledge of respondents was tested on the importance of DNA analysis in a natural disaster, majority 51(51%) of the respondents said they don't know that in a natural disaster, DNA could be used to identify victims, followed by 41(41%) that knew it can be used while, 8(8%) said no, it cannot be used. The majority of the respondent agreed that an unknown disease can be predicted with the help of DNA testing 48(48%), followed by ''I don't know '' with 43 % (43), while 9(9%) said ''no''. Out of hundred respondents that participated in the study, 70 (70%) of the respondents said yes Government should encourage the establishment of DNA analysis centers through legislation, followed by ''I don't know '' with 27(27%), while 3(3%) said no. Ninety percent (90%) of the respondents perceived DNA analysis technology as very good, 8% as good, while 1% each sees it as not good and strange respectively.

Table: Demographic Characteristic of Respondents

Variables	Frequency (%)	Total (%)
Sex		
Male	45 (45)	100 (100)
Female	55 (55)	
Age		
21-30 Years	40 (40)	
31-40 Years	35 (35)	
41-50 Years	16 (16)	100 (100)
51-60 Years	8 (8)	
> 60 Years	1 (1)	
Marital Status		
Single	46 (46)	
Married	49 (49)	100 (100)
Widow	5 (5)	
Educational Qualification		
Secondary	26 (26)	
Tertiary	55 (55)	100 (100)
Post Graduate	19 (19)	
Vocation		
Student	25 (25)	
Barber	2 (2)	
Plumber	1 (1)	
Mechanic	2 (2)	
Welder	1 (1)	
Tailor	5 (5)	100 (100)
Technician	1 (1)	
Business	5 (5)	
Baker	1 (1)	
Computer Programmer	1 (1)	
Transporter/Driver	1 (1)	
Caterer	2 (2)	
Hair Stylist	1 (1)	
Civil Servant	25 (25)	
Trader	25 (25)	
Medical Personnel	1 (1)	
Electrician	1 (1)	
Religion		
Christian	98 (98)	
Muslim	2 (2)	100 (100)

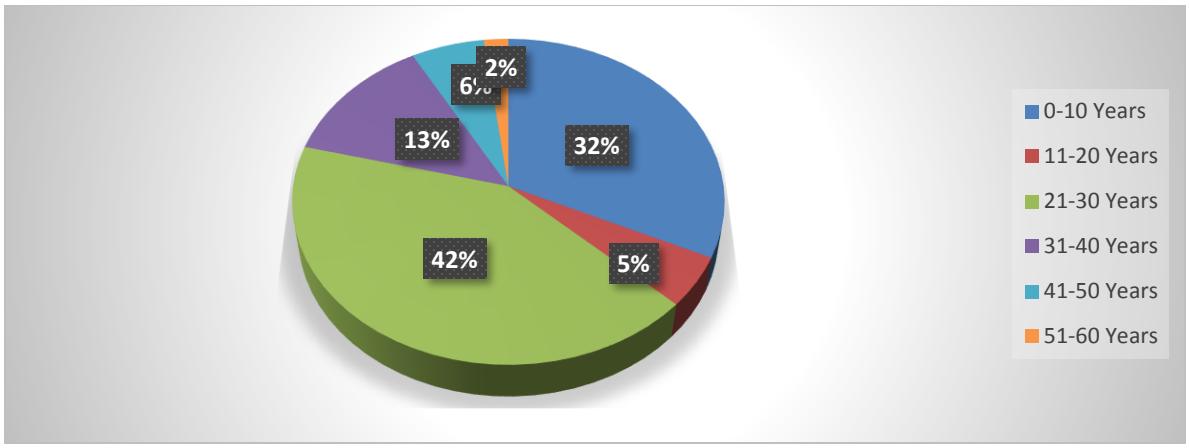

Fig. 1. Length of residency in Benin City, Nigeria

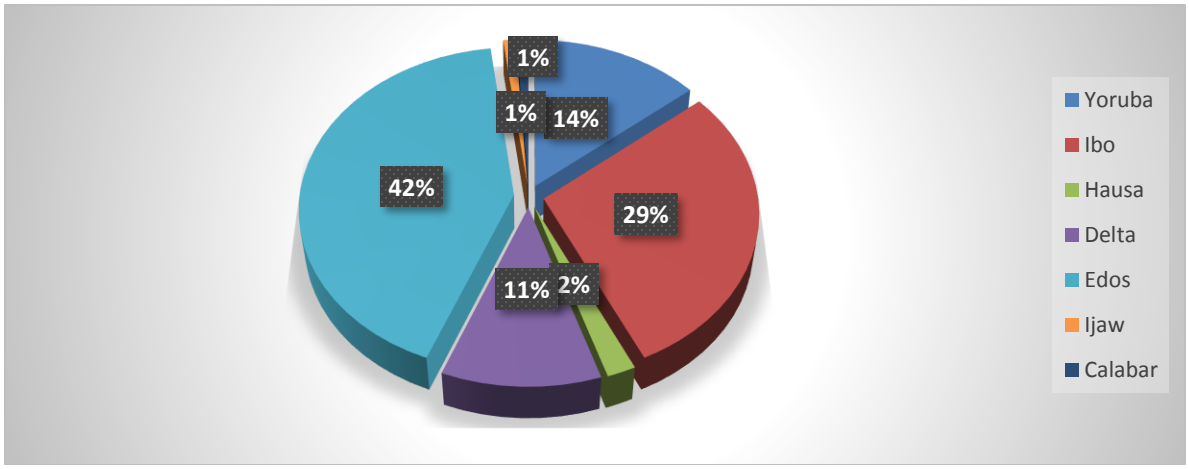

Fig. 2. The ethnicity of the respondents residing in Benin City, Nigeria

Table 2 Awareness of Forensic DNA Analysis

Variables	Frequency (%)	Total (%)
Have you ever been involved in a crime that warranted the use of DNA analysis?		
Yes	3 (3)	100 (100)
No	89 (89)	
Dispute over parenthood	8 (8)	
If yes, did you involve in the medical test as a result of the crime?		
Yes	6 (6)	100 (100)
No	94 (94)	
Have you ever heard of Forensic or DNA Analysis		
Yes	53 (53)	100 (100)
No	47 (47)	
Is there any outfit in Benin City that analyze DNA?		
Yes	29 (29)	
No	71 (71)	100 (100)
Have you been to such a place before?		
Yes	7 (7)	100 (100)

No	93 (93)	
If yes, what for?		
For Enquiry	4 (57.1)	
For Test	3 (42.9)	7 (100)
If the above is for the test, what sample did they request from you?		
Blood	2(66.7)	
Buccal smear	1(33.3)	3 (100)

Table 3: Knowledge of Forensic DNA Testing

Variables	Frequency (%)	Total (%)
What is the full meaning of DNA?		
I know	55 (55)	100 (100)
I don't Know	45 (45)	
Is DNA a living thing?		
Yes	23 (23)	
No	26 (26)	100 (100)
I don't Know	51 (51)	
Where can DNA be found?		
I don't Know	62 (62)	100 (100)
Everywhere	38 (38)	
Can DNA be destroyed?		
Yes	40 (40)	
No	14 (14)	100 (100)
I don't Know	46 (46)	
If the above is yes, by what mean?		
Fire	22 (55)	40 (100)
Water	3 (7.5)	
Chemical	14 (35)	
Sun	1 (2.5)	
Only blood is used as a DNA sample in a laboratory		
Yes	26 (26.3)	
No	31 (30.3)	100 (100)
I don't Know	43 (43.4)	
Do you think with DNA analysis, a crime can be unraveled?		
Yes	58 (58)	
No	6 (6)	
I don't Know	36 (36)	100 (100)
If above is yes, what kind of crimes?		
Murder	21 (61.8)	
Homicide	1 (2.9)	
Rape	5 (14.7)	34 (100)
Robbery	4 (11.8)	
Paternity & maternity dispute	2 (5.9)	
Kidnap	1 (2.9)	
No matter how long a corpse has been buried, can DNA testing still be carried out on it?		
Yes	45 (45.5)	
No	6 (6.1)	99 (100)
I don't Know	48 (48.5)	

Table 4: Perceptions of Forensic DNA Analysis

Variables	Frequency (%)	Total (%)
Can DNA testing be used to share deceased properties in a way?		
Yes	29 (29)	100 (100)

No	19 (19)	
I don't Know	52 (52)	
In a natural disaster, can DNA testing be used to identify victims?		
Yes	41 (41)	
No	8 (8)	100 (100)
I don't Know	51 (51)	
Can the unknown disease be predicted with the help of DNA testing?		
Yes	48 (48)	
No	9 (9)	
I don't Know	43 (43)	100 (100)
Do you believe the government should encourage the establishment of DNA analysis centers through legislation in Nigeria?		
Yes	70 (70)	100 (100)
No	3 (3)	
I don't Know	27 (27)	
Generally, how do you perceive DNA analysis technology?		
Very good	90 (90)	
Good	8(8)	
Not good	1(1)	
Strange	1(1)	100(100)

Discussion

Forensic DNA testing is a powerful tool used to identify, convict, and exonerate individuals charged with criminal offenses, but there are different views on its benefits and risks (Machado and Silva, 2019). Knowledge and awareness about public views on forensic DNA testing applied in the criminal field are socially valuable to practitioners and policymakers. Out of 100 respondents that participated in this study, 45 (45%) of them were male, while 55 (55%) were female. Forty percent (40%) of the respondents were between the age range of 21-30 years, 35(35%) 31-40 years, 16(16%) 41-50 years, 8 (8%) 51-60 years, while 1(1%) was greater than 60 years old. Marital status showed that the majority of the respondents were married 49(49%), 46(46%) single, while 5(5%) are widows. The majority of the respondents had tertiary education with 55(55%), followed by secondary education with 46(46%) and the least being 5(5%) had postgraduate education. The majority of the respondents were students, civil servants, and traders with vocational activity 25(25%) each, followed by tailors and business people, which had 5(5%), barbers, caterers, and mechanics had 2(2%) each, and the minority being plumber, welder, technician, baker, computer programmer, transporter, hairstylist, medical personnel, and electrician that had 1(1%) each. The majority of the respondents were Christians with 98(98%), while 2(2%) were Muslims. Distributions of various ethnic groups among the residents of Benin City revealed that out of the 100 subjects that participate in the study, 42% are Edos 29% are Ibos, 14% are Yorubas, 11% are from Delta, 2% are Hausas, and 1% each is from Ijaw and Calabar. Of the hundred respondents that participated in the study, 89 (89%) of them said they have never been involved in the use of DNA analysis as a result of crime, 3(3%) said yes, they have been involved, while 8 (8%) said they were only involved as a result of a dispute over parenthood. Ninety-four 94(94%) of the respondents were not involved in a medical test involving DNA analysis as a result of crime, while 6(6%) were involved. Fifty-three 53(53%) of the respondents have heard of forensic or DNA analysis before while 47(47%) said they never heard. When the knowledge of participants on DNA analysis outfit in Benin City was tested, seventy-one percent (71%) did not know any outfit in Benin City that analyzed DNA; while 29(29%) knew. When asked if participants have been to any DNA analysis outfit, ninety-three percent (93%) of the respondents said they have not been to any outfit, while 7(7%) said they have. Out of the seven that had visited a DNA analysis laboratory, 4(57.1%) had been there for an inquiry, while 3(42.9%) for testing. Of the three respondents that have been that have there for testing, the blood sample was requested 2(66.7%), while the buccal smear sample 1(33.3%). This is because, in Benin City, only one molecular laboratory exists, it is less than 10 years old, and it was established by a private individual. The chances of its popularity are slim compared to if it is owned by the government. Also, low awareness may be due to low or none existence publicity that the government has given to DNA technology in Nigeria.

Religion and some cultural practices have been found to also hinder the participation of women in social activities, and despite almost 100% Christianity participants, the level of awareness and knowledge is still low which may be due to other factors other than religion.

Among the 100 respondents that participated in this study, 55(55%) of the respondents said yes they know the full meaning of DNA, while 45(45%) didn't know. Fifty-one percent (51%) of the respondents said they don't know if DNA is a living thing, followed by respondents 26(26%), that said DNA is not a living thing, while, 23(23%) knew DNA to be a living thing when asked if DNA is a living thing. The majority 62(62%) of the respondents said they don't know where DNA can be found, and 38(38%) said they can find DNA everywhere.

The majority 46(46%) of the respondents said they don't know that DNA can be destroyed, followed by respondents who said DNA cannot be destroyed 14(14%), while 40(40%) respondents said it can be destroyed. Out of forty respondents that said that DNA can be destroyed, the majority 22(55%) of them said that fire can destroy DNA, 14(35%) said that only chemical can destroy it, while 3(7.5%) and 1(2.5%) respondents said water and sun can destroy DNA respectively. Out of the ninety-nine respondents that responded to whether blood is the only sample used for DNA testing, majority 43(43.4%) of the respondents said that they don't know if blood is the only sample used for DNA analysis, 26(26.3%) said it is only blood while 30(30.3%) said it is not only blood. When it was asked if DNA analysis can be used to unravel the crime, majority 58(58%) of the respondents said DNA analysis can be used to unraveled crime, followed by the respondent that said they don't know if DNA analysis can be used to unraveled crime and 6(6%) said no, that DNA analysis can't be used to unraveled crime. Out of the 100 respondents, only 34 had a response to the kind of crimes DNA analysis can be used to unravel, majority 21(61.8%) of the respondents said murder is the crime they do know, followed by rape with 5(14.7%), 4(11.8%) robbery, 2(5.9%) paternity and maternity, and the least being 1(2.9%) each for homicide and kidnap respectively. When the knowledge of the respondents was tested on whether DNA analysis can be carried out on a orpse no matter how long it was buried? 45(45.5) said yes, 6(6.1) said no, while 48(48.5) did not know.

When the respondents were asked, if DNA analysis can be used to select a spouse, the majority 56(56%) of the respondents said yes, followed by ''I don't know'' with 39(39%), and the least 5(5%) that said ''no,'' DNA testing cannot be used to select a spouse. The majority of the participants could not differentiate between the normal basic ABO blood group and genotype testing used for marriage compatibility. The majority of the respondents 52(52%) said they don't know that DNA testing can be used to share deceased properties in a way, followed by 29(29%), who said yes, and the least 19(19%) said ''no DNA testing cannot be used to share deceased properties in any way. The majority 51(51%) of the respondent said they don't know that during a natural disaster, DNA testing could be used to identify victims, 41(41%) said it can be used while 8(8%) said no it cannot be used. The majority 48(48%) of the respondent said that an unknown disease can be predicted with the help of DNA analysis, 43% said they don't know, while 9(9%) that said ''no'' it cannot be used to predict unknown diseases. Large numbers out of the hundred respondents that participated in the study, seventy (70%) of them said Government should encourage the establishment of DNA analysis centers through legislation in Nigeria, followed by ''I don't know'' response with 27(27%) and 3(3%) saying no. On the general perception of DNA analysis, 80% of the respondents perceived it to be very good, 8% as good, while 1% each saw it as not too good and strange respectively. The fairly high general awareness, knowledge, and perception of DNA analysis by the participants in this study may be because the majority of Benin City residents are vast, highly educated and literates even though, DNA technology may not have been adjudged to be physically on the ground. However, the government needs to do more in the areas of provision of infrastructural facilities, basic amenities, and improve public awareness in this area of work.

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References

Adams, I., Christopher, J., Williams, K.P., Sheppard, V.B. (2015). What black women know and want to know about counseling and testing for BRCA1/2. *J Cancer Educ*.;30(2):344–52.

Etchegary, H. (2014). Public attitudes toward genetic risk testing and its role in healthcare. *Personalized Med*.;11(5):509–22.

Gammon, A.D, Rothwell, E, Simmons R, Lowery, J.T., Ballinger, L., Hill, D.A, Boucher, K.M. Kinney, A.Y. (2011). Awareness and preferences regarding BRCA1/2 genetic counseling and testing among Latinas and non-Latina white women at increased risk for hereditary breast and ovarian cancer. *J Genet Couns*.; 20(6):625–638.

Ge, J., Sun, H., Li, H., Liu, C., Yan, J., Budowle, B. (2014). Future directions of forensic DNA databases. Croat Med J. 2014;55(2):163–166. https://doi.org/10.3325/cmj.2014.55.163.

Gill, P. (2019). DNA evidence and miscarriages of justice. Forensic Sci Int. ;294:e1–3
3. https://doi.org/10.1016/j.forsciint.2018.12.003.

Haga, S.B, Barry, W.T., Mills R, Ginsburg, GS, Svetkey L, Sullivan J, Willard H.F (2013). Public knowledge of and attitudes toward genetics and genetic testing. Genet Test Mol Biomarkers.;17(4):327–35.

Heck JE, Franco R, Jurkowski JM, Sheinfeld Gorin S (2008). Awareness of genetic testing for cancer among United States Hispanics: the role of acculturation. J Community Genet.;11(1):36–42.

Henneman, L., Vermeulen, E., van El CG, Claassen L., Timmermans D.R, Cornel MC (2013). Public attitudes towards genetic testing revisited: comparing opinions between 2002 and 2010. Eur J Hum Genet.; 21(8):793–799.

Hindmarsh, R., Prainsack, B. (2010). Genetic suspects: global governance of forensic DNA profiling and databasing. Cambridge: Cambridge University Press.

Honda, K. (2003). Who gets the information about genetic testing for cancer risk? The role of race/ethnicity, immigration status, and primary care clinicians. Clin Genet.; 64:131–6.

Huang, H, Apouey, B., Andrews, J. (2014). Racial and ethnic disparities in awareness of cancer genetic testing among online users: internet use, health knowledge, and socio-demographic correlates. *J Consum Health Internet*.; 18(1):15–30.

Jakovski Z, Ajanovska R, Stankov A, Poposka V, Bitoljanu N, Belakaposka V. (2017). The power of forensic DNA databases in solving crime cases. Forensic Sci Int. ;6:e275– 276 https://doi.org/10.1016/j.fsigss.2017.09.085.

Kaplan CP, Haas JS, Perez-Stable EJ, Gregorich SE, Somkin C, Des Jarlais G, Kerlikowske K. (2006). Breast cancer risk reduction options: awareness, discussion, and use among women from four ethnic groups. Cancer Epidemiol Biomark Prev.;15(1):162–166.

Machado, H. and Silva, S. (2019). What influences public views on forensic DNA testing in the criminal field? A scoping review of quantitative evidence. *Hum Genomics* 13**,** 23-28

National Institute of Justice, (2012). DNA Evidence: BasicsofAnalyzing,"nij.ojp.gov:https://nij.ojp.gov/topics/articles/dna-evidence-basics-analyzing.

National Population Commission (NPC) [Nigeria] and ICF International (2014). Nigeria Demographic and Health Survey 2013. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International.

Pagan, J.A. Su, D., Li, L., Armstrong, K., Asch, DA. (2009). Racial and ethnic disparities in a.wareness of genetic testing for cancer risk. *Am J. Prev Med*.;37(6):524–530.

Peters, N, Rose, A, Armstrong, K. (2004). The association between race and attitudes about predictive genetic testing. Cancer Epidemiol Biomark Prev.;13(3):361–5.

Saad, R. (2005). Discovery, development, and current applications of DNA identity testing. Proceedings (Baylor University. Medical Center). 18(2): 130–133.

Toom V. (2018). Cross-border exchange and comparison of forensic DNA data in the context of the Prüm Decision. Civil liberties, justice and home affairs.

Vadaparampil, S.T., Wideroff, L., Breen, N., Trapido, E. (2006). The impact of acculturation on awareness of genetic testing for increased cancer risk among Hispanics in the year 2000 National Health Interview Survey. Cancer Epidemiol Biomark Prev.;15(4):618–623.

Wienroth, M., Morling, N., Williams, R. (2014) Technological innovations in forensic genetics: social, legal and ethical aspects. Recent Adv DNA Gene Seq. 2014;8(2):98–103.