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Knowledge, Attitude, and Perception of Nursing Students in Selected Private Universities on Integration of Genomic Information Into Clinical Assessment and Patient Education: A Descriptive Cross-Sectional Survey

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ABSTRACT

Background and Aims: The rapid growth of genomics in healthcare has led to significant advances, and the integration of genetic information into clinical and patient education among nursing students during their training years is crucial to equip them for the genomic era. Therefore, this study assessed nursing students' knowledge, attitudes, and perceptions of integrating genetic information into clinical assessment and patient education.

Methods: A descriptive cross-sectional study was conducted among 265 nursing students using the purposive sampling technique, from selected institutions. Data were collected over 2 months using structured questionnaires and analyzed using SPSS version 25.0. Results were presented in frequencies and percentages. Association between variables was tested using binary logistic regression and chi-square at $p \leq 0.005$.

Results: The mean age of respondents was 22 ± 3 years. Overall, 74% had good knowledge of genomic concepts, 66% showed positive attitudes, and 59% had good perception towards integration of genomics into care. Key factors influencing integration included religious teachings (85%), family values (88.3%), access to genetic testing (89.8%), and lack of institutional support (92.5%). Binary logistic regression identified nurses' lack of genomic knowledge (OR = 6.00; 95% CI: 3.65–9.87; $p = 0.001$), unclear understanding of nursing roles (OR = 0.25; 95% CI: 0.08–0.80; $p = 0.019$) and limited patient financial resources (OR = 0.25; 95% CI: 0.07–0.87; $p = 0.029$) were significantly associated with poor knowledge.

Conclusion: Nursing students at selected private institutions demonstrated a good grasp of genomic information, along with positive attitudes and perceptions about its integration into their practice. To ensure the proper delivery of personalized care in this new genomic era, nursing students must be educated on their roles as nurses in this area.

1 | Introduction

The use of genomics in global healthcare has grown rapidly, leading to transformative advances in healthcare through genetic and genomic discoveries [1, 2]. Despite these developments, there remains a significant gap in the widespread implementation of genetic and genomic care competencies, particularly in low- and middle-income countries. This

highlights the growing need for genomic literacy and personalized healthcare in these regions [3].

The understanding that researchers have gained about how genetic variation affects health and well-being has had a profound and transformative impact on patients, families, and communities [4]. Whereas genetics is concerned with the precise gene structure as it exists in the cell, genetic variation, and heredity in animals,

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Summary

- What is Known About This Topic
 - Previous research has identified a significant gap in genetic literacy between nursing educators and learners, highlighting deficiencies in understanding and practical implementation.
- What This Paper Adds to the Topic
 - This study found that there is good knowledge, attitude, and perception towards the integration of genomic information into clinical assessment and patient education. Therefore, fostering good knowledge, attitudes, and perceptions of genomic integration among nursing students lays the foundation for a future nursing workforce that is adept at using genomic information to improve patient care, promote health equity, and drive advances in healthcare practice and research.

genomics provides a static and comprehensive view of an organism's genetic material. Consequently, since every disease and condition has a genetic or genomic component, genetics and genomics should be a key component of nursing practice [5, 6].

The Human Genome Project (HGP) changed the course of healthcare in April 2003. The HGP has mapped and sequenced the approximately 20,000 genes of the human genome, providing a wealth of genetics-genomics knowledge that can be translated into healthcare [7]. Over the past two decades, advances in medical genetics and gene-genetic innovations have transformed healthcare by providing new insights into the management, treatment, monitoring, diagnosis, and prevention of a wide range of genetic disorders. As a result of these advances, all healthcare providers now need to be knowledgeable about genetics and genomics [8].

In the genomic era, there is an increasing need for personalized care. Therefore, nursing students and practising nurses need to be better equipped to apply knowledge of genetics and genomics to nursing practice [9]. Nurses make up the majority of the world's healthcare workforce and are essential for system coordination and continuity of patient care [10]. Furthermore, there is a notable lack of research focusing on nursing students' knowledge, attitudes, and perceptions of the integration of genetic information into clinical assessment and patient education within specific cultural and regional contexts such as Nigeria and other African countries. Previous research has shown a lack of policy and limited application of genetic information in practice [5, 11–13].

With the ongoing advances in genomic medicine in Nigeria and Africa, there is a need for physicians and those in training to acquire some form of genomic literacy. Previous surveys of healthcare providers in developed countries have revealed gaps in the knowledge required. Many felt inadequately prepared and believed that they should have more exposure to genomic medicine during their training [14].

According to a study conducted in Nigeria, more research on genomics is needed, with the hope that examining genomic knowledge will highlight the need to develop curricula for nurses that specifically address genetic content. Africa also needs to benefit from genomics,

empowerment, and other factors. As a result, future nurses will be equipped with the knowledge necessary to reduce the risks associated with genome-related diseases through risk assessment, diet, lifestyle changes, and personalized medication [5].

Incorporating genomic information into the clinical assessment and patient education of nursing students or future nurses during their training years is essential to ensure that they are fully equipped to apply all that they have learnt and to delve deeper into genomic studies to improve patient care. However, this depends on various factors such as students' knowledge and willingness to learn about genomics during their nursing education.

Based on this premise, this study was conducted to assess the knowledge, attitudes, and perspectives of nursing students in selected private institutions on the integration of genetic information into clinical assessment and patient education. As well as identified factors that could influence its integration.

2 | Methods

A descriptive study design was used to assess the knowledge, attitudes, and perceptions of nursing students in selected private universities regarding the integration of genomic information into clinical assessment and patient education. As well as identified factors that could influence its integration. The study adopted a cross-sectional research design. This design was chosen because of the broad scope of the survey method and because it allows a great deal of information to be obtained from a large population, as data collection could be spread over a large geographical area [15]. The research was conducted in two nursing institutions, namely: Faculty of Nursing, Bowen University, Ogbomosho, Oyo State, and Department of Nursing, Lead City University, Ibadan, Oyo State. Faculty of Nursing, Bowen University, established on 17 July 2001 by the Nigerian Baptist Convention on the old 1300-acre (6 km²) campus of the Baptist College, Bowen University commenced academic activities in 2002 with 506 pioneer students and was approved to offer degree programs in Medicine, Anatomy, and Physiology in 2011. The university now has a total student population of 6000.

The university offers a wide range of undergraduate and post-graduate programs in its various accredited colleges, including the College of Agriculture, Engineering and Science, the College of Management and Social Sciences, the College of Liberal Studies, the College of Computing and Communication Studies, the College of Health Sciences, the College of Environmental Science and the College of Law. The Faculty of Nursing is part of the College of Health Sciences with a total of 520 students from 1st year–5th year. Department of Nursing, Bowen University, 3rd year (128), 4th year (48), and 5th year (46), and for this study, 224 students of the total population of nursing students. Department of Nursing, Lead City University, the university moved from its temporary campus in Jericho, Ibadan, to its permanent site in 2007, a sprawling 100-acre campus at the Toll Gate Area, Lagos-Ibadan Expressway, Ibadan, Oyo State, Nigeria. The campus houses faculty buildings, science laboratories, engineering workshops, student hostels, chapel,

university mosque, stadium complex, student center, bookshop, supermarket, cafeteria, and two broadcasting studios.

When the university was founded, there were four faculties; at present there are eleven faculties, including the Faculty of Environmental, Social and Management Sciences, the Faculty of Communication and Information Sciences, the Faculty of Applied Sciences, the Faculty of Arts and Education, the Faculty of Law, the Faculty of Engineering and Technology, the Faculty of Clinical Sciences, the Faculty of Basic Medical Sciences, the Faculty of Pharmacy and the Faculty of Public Health. The Department of Nursing, Lead City University, Ibadan, was established in 2017 and admitted its first batch of students in the 2017/2018 session and was accredited in April 2019. The department has a total of about 650 students. The 3rd year (154), 4th year (124), and 5th year (106) include students from the Department of Nursing, Lead City University. For this study, a total of 384 nursing students were used.

A total of 265 students formed the sample size using Taro Yamane's [16] formula. The purposive sampling technique was explored because the selected population was knowledgeable about genomic nursing. The third, fourth and fifth-year nursing students were purposively selected to participate in this study because of their knowledge of genomic information were included in the study. A 46-item structured questionnaire developed based on an extensive review of related literature was used to collect data from respondents on the integration of genomic information into clinical assessment and patient education. Section A: has 7 items on socio-demographic variables. Section B: has 20 items that elicit information on nursing students' knowledge of genomic concepts. The knowledge question was categorized as "good knowledge score 39–50; poor knowledge score 0–38).

Section C: has 10 items that elicit information on attitudes towards the integration of genomic information into clinical assessment and patient education. Respondents' attitudes were further categorized as "good" and "poor" (good attitude score 30–50; poor attitude score 10–29). Section D: has 9 items to elicit information on perceptions of the integration of genomic information into clinical assessment and patient education. The perception score was further categorized into "positive perception" and "negative perception" (positive perception score 27–45; negative perception scores 9–26). The instrument was reviewed by an expert in the field of medical-surgical nursing and nursing genomics for content validity. The internal consistency of the study was measured and found to be 0.70 using Cronbach's alpha.

Data collection took place over a period of 6 weeks. The instrument, a questionnaire (Online Google form), was distributed to respondents by the researcher through the class WhatsApp page after obtaining informed consent. Respondents were guided through the process of answering the questionnaire by clear instructions on how to complete the form. Confidentiality and protection of their responses were assured and reiterated. This provided an opportunity for the researcher to meet the respondents virtually and explain the reason for the study and clarify areas where clarification was needed.

Ethical approval for the study was sought and obtained from the Research Ethics Committee of Lead City University (ethics approval number: LCU-REC/24/005) and UI/UCH (ethics approval number: UI/EC/24/0157). A copy of the research proposal, ethics approval, and an introductory letter for data

collection were submitted to the appropriate bodies at the institutions where data were collected (Bowen University and Lead City University). Participants' details such as name, home address, telephone number, marital status, and date of birth were not collected to ensure that the data obtained were as anonymous as possible. Participants in the study were treated with the utmost respect for their dignity and self-respect, and there was no inhumane treatment of any kind. The method of data collection was not invasive in any way. Participation in the research did not cause any pain or discomfort to the respondents; their time would be required for participation. The participants in this study were students who were given the right to choose whether or not to participate in the study. Participants were free to withdraw from the study at any time at no cost to them.

In this study, the data obtained were checked for errors and completeness. The analysis was carried out using IBM SPSS (Statistics version 25). Descriptive statistics (frequency and percentage) were used to describe the sample characteristics and responses. Inferential statistics (chi-square test and binary logistic regression) were used to test the variables for association and to identify the predictors of genomic knowledge among nursing students. Analysis was pre-specified; the subgroup analyzes (gender, ethnicity, level of study) were exploratory. A two-sided significance level was set *a priori* at $p \leq 0.005$. Statistical terms and symbols used are Probability value (*P*), Odd ratio (OR), and Confidence Interval (CI).

3 | Results

3.1 | Socio-Demographic Characteristics of Respondents

Table 1 shows that less than half (45.5%) of the respondents were aged between 21 and 25 years, with an overall mean age of 22 ± 3 years. In terms of gender, most respondents (78.9%) were female. Most respondents (95.9%) were single, 79.7% were Christian by religion, and 71.8% were Yoruba by ethnicity.

3.2 | Knowledge of Nursing Students About Genomic Concepts

As shown in Table 2, most respondents (92.9%) agree that genomic information primarily focuses on the study of individual genes and their functions. Similarly, the majority (89.5%) agree that genomic information is the comprehensive data obtained from studying the entire genome of an organism. Most respondents agreed that integrating genomic information would effectively identify genetic mutations that could reduce the likelihood of developing a disease (92.1%) and help healthcare providers dispel myths surrounding hereditary disorders (91.7%). Regarding clinical conditions requiring the integration of genomic information into clinical assessment and patient education, the majority identified systemic lupus erythematosus (89.5%), schizophrenia (81.6%), and thalassemia (80.1%) as such conditions. However, most respondents agreed that genomic information should be included in preconception care (92.1%), premarital counseling (95.9%) and cancer care (83.1%).

Figure 1 above shows the level of knowledge of genomic concepts among nursing students. More than two-thirds, 197(74%),

TABLE 1 | Socio-demographic characteristics of respondents.

Variables	Categories	Frequency (<i>n</i> = 265)	Per cent (%)
Age (as of last birthday)	20 Years below	62	23.3
	21–25 years	121	45.5
	26–30 years	77	28.9
	31 years above	6	2.3
	Mean $\pm$ SD		22 $\pm$ 3 years
Sex	Female	209	78.6
	Male	57	21.4
Marital status	Married	11	4.1
	Single	255	95.9
Religion	Christianity	212	79.7
	Islam	52	19.5
	Traditionalist	2	0.8
Ethnicity	Hausa	4	1.5
	Igbo	57	21.4
	Yoruba	191	71.8
	Others	14	5.3
Institution	Bowen University	97	36.5
	Lead City University	169	63.5
Year of study	3rd	123	46.2
	4th	76	28.6
	5th	67	25.2

had good knowledge of genomic concepts and less than one-third, 69(26%), had poor knowledge of genomic concepts.

3.3 | Attitude of Nursing Students Towards the Integration of Genomic Information Into Clinical Assessment and Patient Education

Table 3 below shows the nursing students' attitudes towards integrating genomic information into clinical assessment and patient education; more than half (63.5%) strongly agreed that they are willing to integrate their patient's genomic information into clinical assessment and health education to improve adherence to clinical recommendations, more than half (60.9%) strongly agreed that they are willing to integrate their patient's genomic information into clinical assessment and health education, thereby improving adherence to clinical recommendations; more than half (60.9%) strongly agreed that they are willing to use their patient's genomic information to guide their care plan and other areas of patient health decision-making; more than half (59%) strongly agreed that a good understanding of genomics would improve clinical assessment and patient education and help patients make informed decisions about their health.

Figure 2 shows the level of nursing students' attitudes towards the integration of genomic information into clinical assessment and patient education: about two-thirds (66%) had a good attitude towards the integration of genomic information into clinical assessment and patient education,

and about one-third (34%) had a poor attitude towards the integration of genomic information into clinical assessment and patient education.

3.4 | Perception of Nursing Students on the Integration of Genomic Information Into Clinical Assessment and Patient Education

Table 4 shows nursing students' perceptions of the integration of genomic information into clinical assessment and patient education; more than half (57.9%) strongly agreed that genomic nursing is an important aspect of healthcare that should be introduced to nursing students, less than half (47.7%) strongly agreed that including genomics in the curriculum would help nursing students to integrate patients' genomic information into clinical assessment and patient education, less than half (46.2%) agreed that the role of genomics will shape the future of healthcare, but less than a third (32.3%) agreed that integration of genomic information obtained from patients could be misused by companies or government bodies.

Figure 3 shows the level of perception of the integration of genomic information into clinical assessment and patient education, more than half 158 (59%) had a positive perception of the integration of genomic information into clinical assessment and patient education and less than half 108 (41%) had a negative perception of the integration of genomic information into clinical assessment and patient education.

TABLE 2 | Knowledge of nursing students about genomic concepts.

Variables	True F (%)	False F (%)
Genomic information primarily focuses on the study of individual genes and their functions	247 (92.9)	19 (7.1)
Genomic information is comprehensive data gathered from the study of an organism's entire genome	238 (89.5)	28 (10.8)
Genomic information is static and does not change over time	137 (51.5)	129 (48.5)
Genetic counseling is only recommended for individuals with a family history of genetic disorders	129 (48.5)	135 (51.5)
The field of genomics is primarily focused on the study of environmental factors influencing gene expression	175 (65.8)	91 (34.2)
The integration of patients' genomic information will be effective in		
Assisting the healthcare providers in determining and understanding the severity of a disease or disorder	234 (88)	32 (12)
Identifying genetic mutations that may decrease the likelihood of developing a disease	245 (92.1)	21 (7.9)
Identifying genetic mutations that could be passed on to the child of the patient	234 (88)	32 (12)
Guiding healthcare providers in decision-making of the best treatment to use for certain individuals	237 (89.1)	29 (10.9)
Screening neonates and adults is at risk of certain treatable conditions	235 (88.3)	31 (11.7)
Aiding generalized care of patients and their families	230 (86.5)	36 (13.5)
Helping healthcare providers debunk myths surrounding heritable disorders.	244 (91.7)	22 (8.3)
Variables	True (F%)	False (F%)
The following clinical conditions require the integration of genomic information into clinical assessment and patient education.		
Systemic lupus erythematosus	238 (89.5)	28 (10.8)
Prostate cancer	207 (77.8)	59 (22.2)
Cardiovascular diseases	207 (77.8)	59 (22.2)
Depression	140 (52.6)	126 (47.4)
Schizophrenia	217 (81.6)	49 (18.4)
Type II diabetes mellitus	205 (77.1)	61 (22.9)
Thalassemia	213 (80.1)	53 (19.9)
Genomic information should be included in:		
Pre-conception care	245 (92.1)	21 (7.9)
Pre-marital counseling	255 (95.9)	11 (4.1)
Cancer treatment	221 (83.1)	45 (16.9)
HIV/AIDS treatment	152 (57.1)	114 (42.9)
Families with no history of breast cancer in four (4) generations	144 (54.1)	122 (45.9)
Behavioral therapy	172 (64.7)	94 (35.3)

3.5 | Factors Influencing the Integration of Genomic Information Into Clinical Assessment and Patient Education

Table 5. shows the factors influencing the integration of genomic information into clinical assessment and patient education; the majority agreed that religious teachings and beliefs of patients and nurses (85%), family values, norms and beliefs of patients (88.3%), access to genetic testing and counseling services even at grassroots level (89.8%) and lack of support from institutions to integrate genomic information into clinical assessment and patient education (92.5%) are the factors influencing the integration of genomic information into clinical assessment and patient education.

3.6 | Hypothesis Testing

Socio-demographic variables (gender, year of study, institution) and nursing students' attitudes towards integrating genomic information into clinical assessment and patient education

Table 6 presents the analysis of the relationship between socio-demographic variables of ethnicity, year of study, and institution and nursing students' attitudes towards integrating genomic information into clinical assessment and patient education at $p < 0.05$.

The Chi Square test analysis revealed that there is no significant association between ethnicity and nursing students' attitudes towards integrating genomic information into clinical assessment

and patient education with ($X^2 = 7.318$; degree of freedom (df) = 3; $p = 0.062$).

Level of knowledge of genomic concepts and the factors influencing the integration of genomic information into clinical assessment and patient education.

Table 7 presents the analysis of nursing students' knowledge of genomic concepts and the factors influencing the integration of genomic information into clinical assessment and patient education.

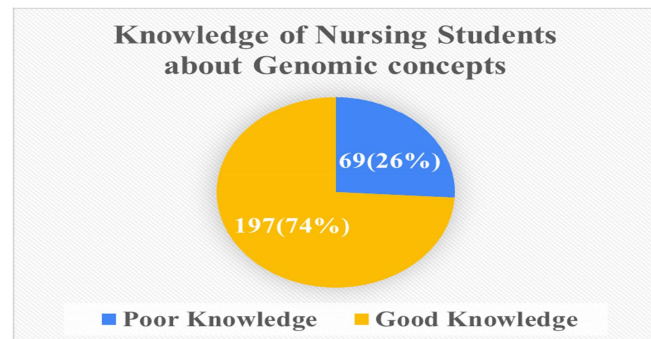


FIGURE 1 | Level of knowledge of nursing students about genomic concept.

Binary logistic regression revealed that for nurses' lack of knowledge of genomics (Odd ratio [OR] = 6.00; 95% Confidence Interval [CI]: 3.65–9.87; $p = 0.001$), indicating a significant association. The odds of nursing students having “Good Knowledge” of genomic concepts are six times higher. Patient financial resources have little effect on the integration of genomic information (OR = 0.25; CI: 0.07–0.87; $p = 0.003$). Nurses' lack of

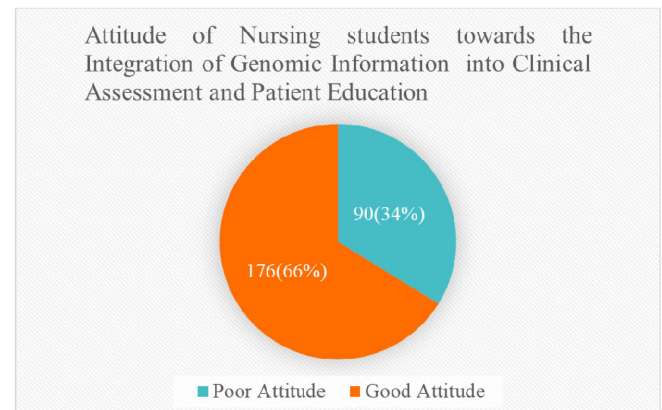


FIGURE 2 | Level of attitude of nursing students towards the integration of genomic information into clinical assessment and patient education.

TABLE 3 | Attitude of nursing students towards the integration of genomic information into clinical assessment and patient education.

Variables	SA F (%)	A F (%)	N F (%)	D F (%)	SD F (%)
Willing to integrate the genomic information of my patient into clinical assessment and health education, thereby improving adherence to clinical recommendations	169 (63.5)	80 (30.1)	7 (2.6)	3 (1.1)	7 (2.6)
Willing to use my patient's genomic information to guide my plan of care and other areas of decision-making regarding my patient's health	162 (60.9)	98 (36.8)	0 (0)	3 (1.1)	3 (1.1)
Having a good understanding of genomics would enhance clinical assessment and patient education and assist patients in making informed decisions concerning their health.	157 (59)	68 (25.6)	9 (3.4)	9 (3.4)	23 (8.6)
Open to trying out new trends and interventions in carrying out clinical assessment and patient education	114 (42.9)	105 (39.5)	19 (7.1)	7 (2.6)	21 (7.9)
Nurses need to be involved in the use of patients' genomic information in carrying out clinical assessment and patient education	36 (13.5)	27 (10.2)	32 (12)	89 (33.5)	82 (30.8)
Patients and their families have a right to know if they are at risk of developing a genetic disease	131 (49.2)	77 (28.9)	29 (10.9)	10 (3.8)	19 (7.1)
Integration of a patient's genomic information into clinical assessment and patient education could increase the anxiety of patients and their families	65 (24.4)	84 (31.6)	39 (14.7)	56 (21.1)	22 (8.3)
Integration of a patient's genomic information into clinical assessment and patient education should be promoted to improve patient health outcomes	113 (42.5)	109 (41)	19 (7.1)	8 (3)	17 (6.4)
Integration of a patient's genomic information into clinical assessment and patient education should be discouraged to prevent family members from stigmatizing anyone susceptible	62 (23.3)	45 (16.9)	19 (7.1)	99 (37.2)	41 (15.4)
Social media will be an effective channel to promote the importance of genomic testing	113 (42.5)	111 (41.7)	22 (8.3)	16 (6)	4 (1.5)

Abbreviations: A, agree; D, disagree; N, neutral; SA, strongly agree; SD, strongly disagree.

TABLE 4 | Perception on integration of genomic information into clinical assessment and patient education.

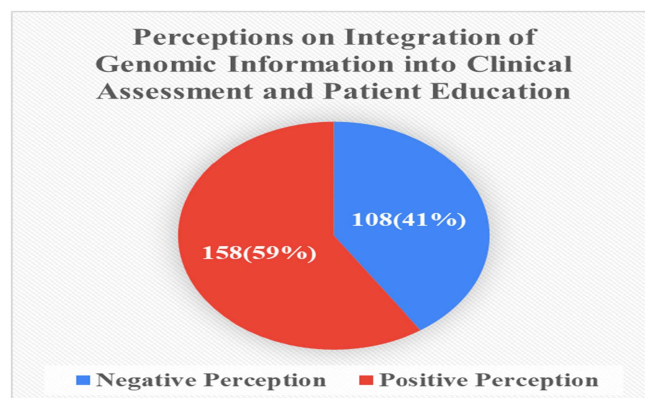
Variables	SA F (%)	A F (%)	N F (%)	D F (%)	SD F (%)
Genomic nursing is an important aspect of healthcare that should be introduced to nursing students	154 (57.9)	85 (32)	18 (6.8)	4 (1.5)	5 (1.9)
Including genomics into the curriculum would help nursing students in the integration of patients' genomic information into clinical assessment and patient education	127 (47.7)	105 (39.5)	24 (9)	2 (0.8)	8 (3)
Genomic education is important to keep student nurses as a central partner in patient/family care	103 (38.7)	102 (38.3)	42 (15.8)	15 (5.6)	4 (1.5)
Family history assessment with genetics/genomics content (i.e., pedigree, 3 generations, age at diagnosis) has little value for patient care	73 (27.4)	56 (21.1)	12 (4.5)	94 (35.3)	31(11.7)
Clinical environment (i.e., hospital setting; clinical setting; hospital administration) motivates me to learn more about genomics	57 (21.4)	109 (41)	48 (18)	39 (14.7)	13 (4.9)
Taking a genetics/genomics course would help me to fully integrate it into the clinical assessment and education of my patients	108 (40.6)	124 (46.6)	17 (6.4)	10 (3.8)	7 (2.6)
Healthcare providers (nurses, physicians, medical laboratory scientists) are ready to integrate genomic information effectively into clinical assessment and patient education	78 (29.3)	104 (39.1)	41 (15.4)	28 (10.5)	15 (5.6)
The role of genomics would shape the future of healthcare delivery	102 (38.3)	123 (46.2)	24 (9)	7 (2.6)	10 (3.8)
Integration of genomic information obtained from patients could be misused by corporate or government bodies	71 (26.7)	86 (32.3)	42 (15.8)	51 (19.2)	16 (6)

understanding of their role about patients' genomic information (OR = 0.25; CI = 0.08–0.80; $p = 0.02$) indicates a significant association between nurses' lack of understanding of their role about patients' genomic information and having a good knowledge of genomic concepts (Table 7).

4 | Discussion of Findings

4.1 | Sociodemographic Characteristics

In the present study, less than half of the respondents were between the ages of 21 and 25 years and the overall mean age of the respondents is 22 ± 3 years, this is somewhat in line with Parvan et al. [17] where the mean age of the participants was 23.02 ± 3.13 years, this can be attributed to the societal and educational context where most of the people in this age group are in tertiary institutions. In terms of gender of the respondents, the majority were female, similar to Adejumo et al. [5] conducted research in Nigeria where majority of the respondents were also female, this may be attributed to broader societal trends or specific factors within the educational or cultural contexts of the populations surveyed which may warrant further studies. This finding highlights the need for active engagement of gender diversity in nursing education and practice in Nigeria. Most of the respondents were Christian; this may be because one of the institutions (Bowen University) is a Christian institution. This illustrates how the ownership of institutions and location can influence the religious composition of the student population in Nigerian private universities. This could potentially influence the ethical perspectives around consent, confidentiality, and faith-related concerns in genomic testing. More than two-thirds of the respondents were

**FIGURE 3** | Level of perceptions on integration of genomic information into clinical assessment and patient education.

Yoruba, like Adejumo et al. [5], where less than half belonged to the same group. This reflects the dominant ethnic group within Southwestern Nigeria, where the study was conducted, is the Yoruba ethnic group. This suggests that the ethnic norms, values, and beliefs may influence the students' attitudes and perceptions of genomic integration into care; a point that warrants further exploration in future studies across different Nigerian regions and ethnic groups.

More than half of the respondents attended Lead City University, with less than half of the respondents being in their third year at the time they completed the questionnaire. Unlike Youssef [18], where the majority of the respondents were in the 5th year, this study included 3rd, 4th, and 5th year students.

TABLE 5 | Factors influencing the integration of genomic information into clinical assessment and patient education.

Variables	Yes F (%)	No F (%)
Nurses' lack of knowledge of genomics	201 (75.6)	65 (24.4)
Religious doctrines and beliefs of patients and nurses	226 (85)	40 (15)
Family values, norms, and beliefs of patients	235 (88.3)	31 (11.7)
The financial resource of the patient has little impact on the integration of genomic information	179 (67.3)	87 (32.7)
Nurses' resistance to changes in terms of genomics	185 (69.5)	81 (30.5)
Nurses' lack of understanding of their roles regarding patients' genomic information	205 (77.1)	61 (22.9)
Ethical and legal considerations	211 (79.3)	55 (20.7)
Access to genetic testing and counseling services, even at the grassroots level	239 (89.8)	27 (10.2)
Lack of support from institutions for integrating genomic information into clinical assessment and patient education	246 (92.5)	20 (7.5)

TABLE 6 | Socio-demographic variables (gender, level of study, institution) and nursing students' attitudes towards integrating genomic information into clinical assessment and patient education.

Variables	Categories	Attitude towards the integration of genomic information into clinical assessment and patient education		χ^2	df	p value
		Good attitude	Poor attitude			
Sex	Female	142 (67.9%)	67 (32.1%)	1.376 ^a	1	0.241
	Male	34 (59.6%)	23 (40.4%)			
Ethnicity	Hausa	3 (75%)	1 (25%)	7.318 ^a	3	0.062
	Igbo	45 (78.9%)	12 (21.1%)			
	Others	11 (78.6%)	3 (21.4%)			
	Yoruba	117 (61.3%)	74 (38.7%)			
Institution	Bowen University	66 (68%)	31 (32%)	0.240 ^a	1	0.624
	Lead City University	110 (65.1%)	59 (34.9%)			
Year of study	3rd	84 (68.3%)	39 (31.7%)	3.732 ^a	2	0.155
	4th	54 (71.1%)	22 (28.9%)			
	5th	38 (56.7%)	29 (43.3%)			

Similarly, Ogamba et al. [14] had conducted a study among Nigerian medical students in their clinical (4th) year. The disparity in the distribution of study levels is due to the differences in the study settings, academic structure, and sampling methods used, suggesting that exposure to genomic educational content may vary across institutions and countries, emphasizing the need for a harmonized curriculum led by regulatory bodies like the Nursing and Midwifery Council of Nigeria to ensure consistent literacy of genomic concepts among Nigerian nursing students.

4.2 | Knowledge of Nursing Students About Genomic Concepts

The present study showed that more than two-thirds had good knowledge of genomic concepts and less than one-third had poor knowledge of genomic concepts, in contrast to the study by [19] in China, where the knowledge level of nurses was moderate and lower across five Chinese provinces as well as studies

among Israeli nurses [20, 21]. This may be due to the different curriculum, the varied operations of the education system, and the extent of integration of genomics within nursing education in different countries.

Notably, the majority of the respondents scored above the pass mark (39/50), indicating good knowledge of genomic concepts, contrary to the findings of the study conducted by Adejumo et al. [5] in Nigeria, where only few scored above 50% on the knowledge component of the modified Genomic Nursing Concept Inventory (GNCI) questionnaire administered. Similarly, a study conducted by Sharoff [4] in America revealed that more than half of the respondents scored poorly, indicating a lack of exposure and understanding of genomic concepts, which supports the findings of Adejumo et al. [5]. The variance in the findings can be attributed to variation in the content of the questions posed, curriculum covered, or local emphasis on genomics, thus suggesting the need for further investigation, development of locally validated and standardized assessment tools in Nigeria, and adapting tools like the GNCI for local context and language.

TABLE 7 | Knowledge of nursing students about genomic concepts.

					95% confidence interval for Exp (B)	
					Lower bound	Upper bound
		df	Sig.	Odd ratio		
Good knowledge	Nurses' lack of knowledge of genomics	1	0.000	6.000	3.648	9.869
	Religious doctrines and beliefs of patients and nurses	1	0.653	1.311	0.403	4.263
	Family values, norms, and beliefs of patients	1	0.358	1.909	0.481	7.578
	The financial resources of the patient have little impact on the integration of genomic information	1	0.029	0.252	0.073	0.865
	Nurses' resistance to changes in terms of genomics	1	0.115	0.414	0.138	1.24
	Nurses' lack of understanding of their roles regarding patients' genomic information	1	0.019	0.254	0.081	0.796
	Ethical and legal considerations	1	0.503	0.790	0.396	1.576
	Access to genetic testing and counseling services, even at the grassroots level	1	0.277	2.134	0.544	8.364
	Lack of support from institutions for integrating genomic information into clinical assessment and patient education	1	0.2	2.156	0.665	6.983
	Constant	1	0.73	0	0	0

The majority attest that genomic information focuses primarily on the study of individual genes and their functions, which points to a potential confusion of the concepts of genomics, yet also agreed that genomic information is a comprehensive set of data obtained from the study of an organism's entire genome, this suggests that a proper understanding of what genomics entails needs to be communicated to nursing students to avoid future confusion as found in this study, thus, reinforcing the need for a clearer emphasis in the nursing curriculum.

Overall, the findings suggest a good knowledge of genomics, with respondents recognizing the potential benefits of integrating genomic information into clinical practice, highlighting the importance of continuing education and training in genomic medicine to ensure its effective integration. The researcher was unable to compare the findings with related studies due to differences in the content of questionnaires administered in other studies, and similar content could not be found in the public domain, suggesting the need for further investigation of knowledge of genomic concepts among nursing students across different regions and programs in Nigeria and Sub-Saharan Africa in future studies.

4.3 | Attitude of Nursing Students Towards the Integration of Genomic Information Into Clinical Assessment and Patient Education

The present study found that approximately two-thirds of respondents had a positive attitude towards integrating genomic information into clinical assessment and patient education. This is consistent with previous research by Youssef [18], who found that nursing students in Saudi Arabia had a similar acceptance of genetics in healthcare practice. This consistency in findings suggests a wider trend towards recognizing the value of genomic information in nursing and highlights the importance of incorporating genomic education into nursing curricula

worldwide, especially into the Nigerian nursing curriculum, led by the regulatory bodies. The finding also demonstrates the readiness of Nigerian nursing students to embrace innovations that can enhance patient-centered care despite existing knowledge gaps, suggesting potential for successful integration of genomic information in clinical assessment and patient education if supported by institutional policies and curriculum reform.

More than half strongly agreed that they were willing to integrate their patients' genomic information into clinical assessment and health education, thereby improving adherence to clinical recommendations, and more than half strongly agreed that they were willing to use their patients' genomic information to guide their care plan and other areas of patient health decision making. These findings are consistent with Carroll's [22] study, where more than half strongly agreed that anticipated advances in genomic medicine would improve patient health outcomes. This suggests that the integration of genomic information into clinical assessment and patient education has the potential to improve patient health outcomes in Nigeria, creating a crucial insight for policymakers in nursing education and practice to strengthen policies and curriculum to allow future nurses to explore innovative means of improving health outcomes and delivery of genomics-informed care.

Approximately one-third disagreed that nurses need to be involved in the use of their patients' genomic information when conducting clinical assessment and patient education, which is consistent with Carroll [22], where less than half disagreed that it was their duty to screen for adult inherited diseases and that it was their duty to apply genomic medicine in practice. This suggests that there is a need to raise awareness of the benefits of nurses' involvement in the use of their patients' genomic information in their care, as nurses often serve as the primary educators and advocates of patients in Nigerian healthcare settings.

Less than half of the participants agreed that social media is an effective channel for promoting the importance of genomic testing, similar to the study by Rehman (2023), who found that the most common sources of knowledge about genetic testing and genomic medicine for participants were internet search engines, as reported by over half of them, and less than half and a significant few reported posters and leaflets, and social media came next. Google ranked highest among internet search engine sources, and Instagram was the most popular social media source [23]. This suggests that social media could be harnessed strategically through structured evidence-based campaigns led by nursing organizations in schools and professional bodies to promote awareness and benefits of genomic testing in this era of global interactions, especially among the young adults in Africa who actively utilize these platforms.

The findings from this study of nursing students' attitudes towards the integration of genomic information into clinical assessment and patient education highlight the need for continuing education and training to prepare and equip nursing students for the integration of genomic information into patient care. This would position nurses in Nigeria and across Africa as the central partners in the implementation of personalized and precision medicine.

4.4 | Perception on Integration of Genomic Information Into Clinical Assessment and Patient Education

This study found that more than half of the respondents had positive perceptions of the integration of genomic information into clinical assessment and patient education, a finding that underscores the growing recognition among healthcare professionals in the United States of the potential benefits of genomics in improving patient care Smith et al. [24] and is particularly encouraging in the African context, where genomic nursing is still emerging. It suggests that the integration of genomic data into clinical practice in Nigeria can facilitate precision medicine approaches, enabling tailored treatment plans based on individual genetic make-up, thus optimizing patient outcomes.

More than half strongly agreed that genomic nursing is an important aspect of healthcare that should be introduced to nursing students, less than half strongly agreed that including genomics in the curriculum would help nursing students to integrate patient genomic information into clinical assessment and patient education, more than a third strongly agreed that genomic education is important to keep nursing students as central partners in patient/family care. Findings from hospitals, clinics, and academic institutions in the United States showed that a significant majority of participants strongly agreed that genomic nursing is an important aspect of health care that should be introduced to nursing students. This is consistent with studies conducted in academic and clinical settings, highlighting the recognition of genomics as essential to modern nursing practice [25]. This highlights the need for an incorporation of structured genomic content in the nursing curricula, as educating nursing students in genomics is essential to equip them with the knowledge and skills necessary for competent nursing practice in the genomic era.

More than a third disagreed that family history assessment with genetics/genomics content has little value for patient care,

similar to the study by Sharoff [4] in America, where the majority of respondents believed that family history assessment with genomics content (i.e., pedigree, three generations, age at diagnosis) would be valuable for patient care. In Nigeria, where there are limited resources and access to genomic testing, family health information is an essential, cost-effective tool to ensure appropriate genetic health data to improve and promote better knowledge of disease progression, treatment efficacy, and drug safety.

Less than half of the respondents agreed that the clinical environment (i.e., hospital environment; clinical environment; hospital administration) motivates them to learn more about genomics, similar to Sharoff [4] in America, where about half of the respondents agreed that their work environment motivates nurses to learn more about genomics. This may be due to the structures and policies put in place in these clinical environments to increase the curiosity of nursing students to learn about genomics, highlighting a need for healthcare institutions to strengthen their organizational support and exposure of students and other personnel to genomics in the clinical environment.

Less than half agreed that attending a genetics/genomics course would help them to fully integrate it into the clinical assessment and education of my patients, in contrast to the study by Sharoff [4] in America, where the majority of respondents agreed that attending a genetics/genomics course would be beneficial in integrating genomics into practice.

More than a third (39.1%) agreed that healthcare providers (nurses, physicians, medical laboratory scientists) are prepared to effectively integrate genomic information into clinical assessment and patient education, in contrast to the findings of Sharoff [4] in America, where a significant majority of respondents are not prepared to integrate genomics into their practice. This may be due to low levels of confidence in their skills in genomics and handling patient genomic data.

Based on the findings of this study, there is a notable positive perception towards the integration of genomic information into clinical assessment and patient education, which implies that genomic nursing is an important aspect of healthcare that should be introduced to nursing students, the role of genomics would shape the future of healthcare, and the inclusion of genomics in the curriculum would help nursing students to integrate patients' genomic information into clinical assessment and patient education. Future research should focus on evaluating the effectiveness of genomic nursing education interventions and their impact on clinical practice outcomes in different healthcare settings.

4.5 | Factors Influencing the Integration of Genomic Information Into Clinical Assessment and Patient Education

This study found that the majority agreed that patients' and nurses' religious teachings and beliefs, family values, norms, and patients' beliefs influence the integration of genomic information into clinical assessment and patient education. In contrast, a study conducted in the United Arab Emirates by Rehman (20–23), which examined the impact of religion on cohort attitudes towards genetic testing, found that more than half of respondents agreed that religion did not conflict with

genetic testing. This may be due to differences in religious perspectives between countries, families, and individuals.

Majority of the respondents agreed that lack of nurses' understanding of their role in relation to patients' genomic information, lack of access to genetic testing and counseling services even at the grassroots level, and lack of institutional support were predictors for the integration of genomic information into clinical assessment and patient education highlighting systemic gaps in the Nigerian healthcare infrastructure, this differed from the findings of the study conducted by Adejumo et al. [5] in Nigeria, where the factors identified, such as lack of money, lack of trained staff, substandard living conditions of most citizens, influence of environment and social issues, are lower than those found in this study. The least common variables found were religious considerations and cultural factors as factors influencing the integration of genomic information into clinical assessment and patient education, which contrasts with the most common variables found in this study may reflect regional differences within Nigeria, which could be explored in further studies qualitatively.

4.6 | Hypothesis Testing

There is no significant association between ethnicity and nursing students' attitudes toward integrating genomic information into clinical assessment and patient education. The results of this finding were inconsistent with the study conducted by Adejumo et al. [5] This suggests that ethnicity may influence attitudes towards integrating genomic information into clinical assessment and patient education, as does their knowledge of genomic concepts.

Binary logistic regression analysis indicates that nurses' lack of knowledge of genomics. Nurses are six times more likely to have poor knowledge of genomics concepts. The result suggests a statistically significant association between nurses' lack of knowledge of genomics and knowledge of genomic concepts. This finding contrasts with previous research that may have emphasized the importance of nurses' genomic literacy in effectively integrating genomic information into patient care. This unexpected finding suggests that more research is needed to identify the elements that influence nurses' knowledge of genomics and its application in clinical practice. It highlights the importance of implementing targeted educational initiatives to close the knowledge gap that exists between nurses and their ability to successfully integrate genetic data into patient care. Patient financial resources have little impact on the integration of genomic information. This indicates that students who agree that the patient's financial resources have little impact on the integration of genomic information have good knowledge of genomic concepts.

The significant association between nurses' lack of understanding of their role regarding patients' genomic information and their knowledge of genomic concepts echoes findings from previous research highlighting the importance of clarifying nurses' roles in genomic medicine [26]. This suggests that addressing nurses' role ambiguity, providing appropriate support, and training are essential for the successful integration of genomic information into clinical care.

5 | Conclusion

In conclusion, the results of this study show that nursing students in the selected private institutions have good knowledge, attitudes, and perceptions towards the integration of genomic information into clinical assessment and patient education. Thus, fostering good knowledge, attitudes, and perceptions of genomic integration among nursing students lays the foundation for a future nursing workforce that is adept at using genomic information to improve patient care, promote health equity, and advance health care practice and research. Addressing the multiple factors that influence the integration of genomic information into clinical assessment and patient education requires a collaborative effort among healthcare institutions, policy makers, educators, and healthcare providers. By addressing knowledge gaps, promoting cultural competence, improving access to services, and providing institutional support, the integration of genomic information into clinical practice can be facilitated, ultimately improving patient outcomes and advancing healthcare delivery. Therefore, nursing students in Nigeria should be educated and trained on their responsibilities with regard to patients' genomic information to enable them to provide accurate, individualized care in the dawning genomic era.

6 | Limitation of Study

This study was conducted in Southwest Nigeria, which is only one of the six geopolitical zones in Nigeria. Therefore, the findings cannot be generalized to other settings in Nigeria because it was conducted in two private institutions and cannot represent what happens in private institutions in other geopolitical zones, and also in public institutions. The relatively small sample size may limit generalizability.

7 | Recommendations

- Nursing students should receive comprehensive education and training in genomics, including basic genetic principles, interpretation of genomic data, and effective communication of genomic information to patients, as well as the inclusion of genomic nursing in the curriculum. Experts in genomic nursing could also organize free or subsidized webinars and training for nursing students to keep them up to date with new trends and innovations in genomics. They should also develop evidence-based clinical guidelines for integrating genomic information into clinical practice. These guidelines should provide clear recommendations for genetic testing, interpretation of results, counseling, and follow-up care to help health professionals navigate the complexities of genomic medicine and can be incorporated into the curriculum.
- A multidisciplinary approach will ensure that genomic information is effectively integrated into patient care plans and that patients receive comprehensive support. Nursing students should therefore be trained in their roles and responsibilities and how to work with other healthcare professionals from different disciplines, such as genetic counselors, physicians, and pharmacists, as this would

promote and enhance the integration of genomic information into clinical assessment and patient education.

- Nursing students should be trained to understand and respect diverse cultural beliefs and values related to genomics. This includes addressing religious teachings and family dynamics that may influence patients' decisions about genetic testing and treatment options.
- Nursing students should be educated and trained to understand policies and protocols that guide the integration of genomic information into clinical assessment and patient education, such as the privacy and security of patients' genetic information and reimbursement for genomic testing.

8 | Suggestions for Future Research

Researchers should use a mixed research design (quantitative and qualitative design) in future studies instead of only a quantitative (cross-sectional) research design as used in this study. Also, future research could include a comparison between public and private institutions.

Author Contributions

Iyanuoluwa Ojo, Toluwanimi Asumo: conceptualization, methodology, data curation, supervision, validation, writing – original draft, writing – review and editing. **Iyanuoluwa Ojo, Toluwanimi Asumo, Ajibola Omobola Ojo, Prisca Olabisi Adejumo:** methodology, software, formal analysis, writing – original draft, writing – review and editing. **Iyanuoluwa Ojo, Toluwanimi Asumo:** conceptualization, writing – original draft. **Iyanuoluwa Ojo, Toluwanimi Asumo, Ajibola Omobola Ojo, Prisca Olabisi Adejumo:** investigation, validation, data curation. **Iyanuoluwa Ojo, Toluwanimi Asumo:** conceptualization, methodology, investigation, writing – original draft.

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Ethics Statement

Ethical approval for the study was sought and obtained from the Research Ethics Committee of Lead City University (ethics approval number: LCU-REC/24/005) and UI/UCH (ethics approval number: UI/EC/24/0157).

Consent

This was not a clinical study, although all participants in the study answered the questions voluntarily. The authors confirmed that informed consent was obtained from all subjects. The authors confirm that all methods were performed following the relevant guidelines and regulations e.g., the Declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest. This study did not receive any specific funding from public, commercial, or non-profit funding agencies. The institutions used did not have any role in study design;

collection, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Transparency Statement

The lead author Iyanuoluwa Oreofe Ojo affirms that this article is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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