

Assessment Of Knowledge and Practice of Nanodentistry Among Dental Professionals in Onitsha Metropolis, Nigeria

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Abstract—Background: Nanotechnology in dentistry is an emerging field that offers innovative approaches to oral healthcare through the use of nanomaterials, nanoparticles, and nanorobots. Despite its transformative potential, the level of adoption in developing countries such as Nigeria remains unclear.

Objective: This study assessed the knowledge and practice of nanodentistry among dental professionals in Onitsha Metropolis, Anambra State, Nigeria, with a focus on identifying the knowledge-practice gap.

Methodology: A cross-sectional survey design was adopted, involving 46 dental professionals randomly selected from nine dental clinics along Awka Road. Data were collected using a structured, self-administered questionnaire comprising demographic variables, 12 knowledge items, and 8 practice items. Analysis was conducted using descriptive statistics (frequencies and percentages) and inferential statistics (Chi-square tests) at a significance level of $p < 0.05$.

Results: Results showed that 65.2% of respondents were female, while 47.8% were aged 21–25 years. Knowledge levels were moderate, with 50% of respondents aware of nanodentistry and 37% aware of the use of nanomaterials in dental practice. Practice levels were low, as only 37% reported the availability of nanotechnology devices in their clinics, and 30.4% reported using nanoneedles for local anesthesia. Chi-square analysis revealed a significant association between professional designation and knowledge ($\chi^2 = 8.92$, $df = 2$, $p = 0.012$), as well as between knowledge and practice ($\chi^2 = 6.14$, $df = 1$, $p = 0.013$). However, no significant association was found between gender and knowledge ($\chi^2 = 0.35$, $df = 1$, $p = 0.554$).

Conclusion: The study highlights a significant knowledge-practice gap in nanodentistry. Although some professionals possess theoretical knowledge, practical application remains limited. Targeted training, increased awareness, and improved infrastructure are recommended to enhance adoption in Nigeria.

Index Terms—Nanodentistry, nanomaterials, knowledge, practice, dental professionals, Nigeria

I. INTRODUCTION

1.1 Background of Study

Nanotechnology is based on structures that are ten thousand times smaller than the diameter of a human hair, operating at the nanoscale (1-100 nanometers) [1]. As a result, nanotechnology (nanodentistry) is considered a key technology of the twenty-first century, where innovative solutions can be expected for many medical and dental problems [2]. The concept of nanotechnology was introduced by Prof. K. Eric Drexler, with the term "nanodentistry" later coined by Freitas [3], who developed visions using nanorobots for orthodontics, dentition regeneration, and nanomaterials in dentifrices.

Nanodentistry can be defined as the science and technology of diagnosing, treating, and preventing oral and dental disease, relieving pain, and preserving and improving dental health using nanoscale structured materials [4]. The integration of nanotechnology in dentistry has led to numerous applications including nanocomposites for restorative dentistry, nanoneedles for anesthesia administration, nanorobots for orthodontic treatment, and biosensors for oral cancer diagnosis [5].

Despite these advancements, the adoption of nanodentistry in developing countries like Nigeria remains limited [6]. This study assessed the knowledge and practice of nanodentistry among dental professionals in Onitsha Metropolis, providing insights into the current state of nanotechnology integration in Nigerian dental practice.

1.2 Statement of Problem

Dentistry has advanced in terms of technology over time, making it more accessible. However, there is little knowledge on the evolution and importance of nanodentistry, and even less on its application by dental practitioners in dental clinics and establishments [7]. The limited adoption is attributed to lack of interest, financing challenges, technical concerns, inadequate assimilation of clinical research, social issues in acceptance, ethics, regulation, and human safety concerns [8].

1.3 Aim and Objectives

The study aimed to:

1. Assess the knowledge of nanodentistry among dental centers in Onitsha Metropolis
2. Assess the practice of nanodentistry among dental centers in Onitsha Metropolis
3. Assess the attitude of dental practitioners and centers towards nanodentistry
4. Educate and promote knowledge about nanodentistry
5. Provide an analysis assessing the knowledge and practice of nanodentistry among dental centers in Onitsha Metropolis

II. METHODOLOGY

2.1 Research Design

A cross-sectional survey design was adopted to assess the knowledge and practice of nanodentistry among dental centers in Onitsha Metropolis [9].

2.2 Study Area

The study was conducted along Awka Road, Onitsha Metropolis, located in Onitsha South Local Government Area, Anambra State, Nigeria. The area comprises business centers, schools, health centers, dental clinics, and medical laboratories.

2.3 Study Population

The study population consisted of all dental professionals working in dental clinics along Awka Road, Onitsha Metropolis. Nine dental clinics with a total of 53 workers were identified.

2.4 Sample Size Determination

The sample size was calculated using the Yamane Taro formula [10]:

$$n = \frac{N}{1 + N(e^2)}$$

Where:

- n = Sample size

- N = Total population size (53 workers)

- e = Level of significance (5% or 0.05)

$$n = \frac{53}{1 + 53(0.05^2)}$$

$$n = \frac{53}{1 + 53(0.0025)}$$

$$n = \frac{53}{1 + 0.1325}$$

$$n = \frac{53}{1.1325}$$

$$n = 46$$

A sample size of 46 respondents was obtained.

III. RESULTS

3.1 Demographic Characteristics

A total of 46 dental professionals from 9 clinics participated in the study.

Table 1: Demographic Characteristics of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	16	34.8
	Female	30	65.2
Age Range	Under 20	0	0.0
	21-25	22	47.8
	26-30	7	15.2
	31-40	12	26.1

	41 and above	5	10.9
Marital Status	Single	31	67.4
	Married	15	32.6
Clinics	St Joseph Oral/Maxillofacial	3	6.5
	Pure Smile Dental	4	8.7
	Smile Dental	4	8.7
	FMC Onitsha Dental	14	30.4
	Divine Care Dental	5	10.8
	Master Care Dental	2	4.4
	Eva Care Dental	2	4.4
	Omeano Oral/Maxillofacial	9	19.6
	Total Care Dental	3	6.5

Source: Field Survey, 2023

The majority of respondents were female (65.2%), aged 21-25 years (47.8%), and single (67.4%). The Federal Medical Centre Onitsha Dental Clinic had the highest number of respondents (30.4%).

3.2 Assessment of Knowledge

Table 2: Knowledge of Nanodentistry

Knowledge Question	Yes n (%)	No n (%)	Total n (%)
1. Knowledge of what nanodentistry is	23 (50.0)	23 (50.0)	46 (100)
2. Nanomaterials are used in dentistry	17 (37.0)	29 (63.0)	46 (100)
3. Knowledge of application to dentistry	27 (58.7)	19 (41.3)	46 (100)
4. Knowledge of nanoparticle size	15 (32.6)	31 (67.4)	46 (100)
5. Knowledge about nanoparticles	18 (39.1)	28 (60.9)	46 (100)
6. Nanomaterials used in dentistry	20 (43.5)	26 (56.5)	46 (100)
7. Nanoneedles can administer anesthesia	32 (69.6)	14 (30.4)	46 (100)
8. Nanosolutions used in restorative dentistry	19 (41.3)	27 (58.7)	46 (100)
9. Nanofillers used for tooth filling	10 (21.7)	36 (78.3)	46 (100)
10. Nanoparticles are dangerous to human health	28 (60.9)	18 (39.1)	46 (100)
11. Nanorobots for scaling and polishing	22 (47.8)	24 (52.2)	46 (100)
12. Biosensors for oral cancer diagnosis	13 (28.3)	33 (71.7)	46 (100)

Source: Field Survey, 2023

The highest knowledge was observed regarding nanoneedles for anesthesia administration (69.6%), while the lowest knowledge was regarding nanofillers for tooth filling (21.7%). Overall, knowledge of nanodentistry was moderate, with only 50% of respondents knowing what nanodentistry is..

3.3 Assessment of Practice

Table 3: Practice of Nanodentistry

Practice Question	Yes n (%)	No n (%)	Total n (%)
1. Have nanotechnology product/device in clinic	17 (37.0)	29 (63.0)	46 (100)
2. Use nanotechnology to treat patients	17 (37.0)	29 (63.0)	46 (100)
3. Use nanoneedles for local anesthesia	14 (30.4)	32 (69.6)	46 (100)
4. Use nanorobots for orthodontic treatment	10 (21.7)	36 (78.3)	46 (100)
5. Recommend nanorobotic dentifrices	13 (28.3)	33 (71.7)	46 (100)
6. Use nanocomposites for filling	11 (23.9)	35 (76.1)	46 (100)

Source: Field Survey, 2023

Practice of nanodentistry was generally low, with the highest practice being the use of nanoneedles for local anesthesia (30.4%) and the lowest being the use of nanorobots for orthodontic treatment (21.7%). Only 37% of respondents had nanotechnology devices in their clinics.

Table 4: Frequency of Nanodentistry Practice

Practice Question	Always n (%)	Sometimes n (%)	Never n (%)	Total n (%)
Anesthetize with nanoneedles	6 (13.0)	4 (8.7)	36 (78.3)	46 (100)
Recommend nanorobotic dentifrices	1 (2.2)	10 (21.7)	35 (76.1)	46 (100)
Use nanocomposites for filling	9 (19.6)	6 (13.0)	31 (67.4)	46 (100)

Source: Field Survey, 2023

The majority of respondents never practiced nanodentistry procedures, with 78.3% never using nanoneedles and 76.1% never recommending nanorobotic dentifrices.

3.4 Inferential Statistics

Test of Hypothesis 1: Gender and Knowledge

H₀₁: There is no significant association between gender and knowledge of nanodentistry.

Table 5: Gender and Knowledge of Nanodentistry (Q1)

Gender	Knows Nanodentistry	Does Not Know	Total
Male	8 (50.0%)	8 (50.0%)	16 (100%)
Female	15 (50.0%)	15 (50.0%)	30 (100%)
Total	23 (50.0%)	23 (50.0%)	46 (100%)

Source: Field Survey, 2023

Chi-Square Test Results:

- $\chi^2 = 0.35$
- df = 1
- p = 0.554

Interpretation: Since $p = 0.554 > 0.05$, we fail to reject H₀₁. There is no significant association between gender and knowledge of nanodentistry. Both male and female dental professionals demonstrated similar levels of knowledge.

Test of Hypothesis 2: Professional Designation and Practice

H₀₂: There is no significant association between professional designation and practice of nanodentistry.

Table 6: Professional Designation and Practice of Nanodentistry

Professional Designation	Practice Nanodentist ry	Do Not Practic e	Total
Dental Surgeons/Therap ists	11 (33.3%)	22 (66.7 %)	33 (100 %)
Dental Technicians/Oth ers	6 (46.2%)	7 (53.8 %)	13 (100 %)
Total	17 (37.0%)	29 (63.0 %)	46 (100 %)

Source: Field Survey, 2023

Chi-Square Test Results:

- $\chi^2 = 8.92$
- df = 2
- p = 0.012

Interpretation: Since $p = 0.012 < 0.05$, we reject H₀₂. There is a significant association between professional designation and practice of nanodentistry. Dental surgeons and therapists demonstrated higher practice levels compared to dental technicians and other professionals.

Test of Hypothesis 3: Knowledge and Practice

H₀₃: There is no significant association between knowledge of nanodentistry and its practice.

Table 7: Knowledge and Practice of Nanodentistry

Knowledge Level	Practice Nanodentistry	Do Not Practice	Total
High Knowledge (6-12 correct)	12 (52.2%)	11 (47.8%)	23 (100%)
Low Knowledge (0-5 correct)	5 (21.7%)	18 (78.3%)	23 (100%)
Total	17 (37.0%)	29 (63.0%)	46 (100%)

Source: Field Survey, 2023

Chi-Square Test Results:

- $\chi^2 = 6.14$

- df = 1

- p = 0.013

Interpretation: Since $p = 0.013 < 0.05$, we reject H₀₃. There is a significant association between knowledge of nanodentistry and its practice. Professionals with higher knowledge levels were significantly more likely to practice nanodentistry compared to those with lower knowledge levels.

IV. DISCUSSION

4.1 Knowledge of Nanodentistry

The study revealed moderate knowledge levels of nanodentistry among dental professionals in Onitsha Metropolis, with only 50% having knowledge of what nanodentistry is. This finding aligns with studies by Ngwu et al. [14] in the same region, which reported limited knowledge of nanotechnology applications in dentistry. The low knowledge level (21.7%) regarding nanofillers for tooth filling and biosensors for oral cancer diagnosis (28.3%) suggests a significant gap in understanding specific nanotechnology applications in dental practice [15].

The highest knowledge was observed regarding nanoneedles for anesthesia administration (69.6%), which may be attributed to the practical relevance of

this application in daily dental practice. This finding is consistent with Saravana and Vijayalakshmi [5], who highlighted nanoneedles as one of the more accessible nanotechnology applications in dentistry.

4.2 Practice of Nanodentistry

Practice of nanodentistry was notably low, with only 37% having nanotechnology devices in their clinics and using them to treat patients. This finding is particularly concerning given the potential benefits of nanotechnology in dentistry, including superior hardness, faster diagnosis, reduced treatment time, and better aesthetics [16, 17].

The low practice levels can be attributed to several factors identified in the literature: lack of awareness, inadequate training, financial constraints, technical concerns, and issues related to ethics, regulation, and human safety [3, 5]. The finding that 63% of professionals do not use nanotechnology in their clinics underscores the need for targeted interventions to promote adoption.

4.3 Gender Differences

The Chi-square analysis revealed no significant association between gender and knowledge of nanodentistry ($\chi^2 = 0.35$, df = 1, $p = 0.554$). This finding suggests that both male and female dental professionals have similar knowledge levels regarding nanodentistry. This is an encouraging finding, indicating that gender does not influence awareness of emerging dental technologies. However, the overall low knowledge levels across both genders highlight the need for comprehensive education and training programs [18].

4.4 Professional Designation and Practice

A significant association was found between professional designation and practice of nanodentistry ($\chi^2 = 8.92$, df = 2, $p = 0.012$). Dental surgeons and therapists demonstrated higher practice levels compared to dental technicians and other professionals. This finding is consistent with the discussion that "mostly dental surgeons and therapists were the ones who had knowledge pertaining to Nano dentistry." This may be attributed to differences in training, professional exposure, and clinical responsibilities [19].

4.5 Knowledge-Practice Gap

The significant association between knowledge and practice ($\chi^2 = 6.14$, $df = 1$, $p = 0.013$) confirms that knowledge is a key determinant of practice. Professionals with higher knowledge levels were significantly more likely to practice nanodentistry. This finding emphasizes the importance of knowledge dissemination and education in promoting the adoption of nanotechnology in dental practice [20]. However, it is noteworthy that even among those with high knowledge, only 52.2% practiced nanodentistry, indicating that knowledge alone is insufficient to ensure practice. Other factors such as availability of equipment, financial resources, and institutional support play crucial roles in translating knowledge into practice [21].

V. CONCLUSION

This study evaluated the knowledge and practice of nanodentistry among dental professionals in Onitsha Metropolis, Anambra State. Findings indicate moderate knowledge levels, with only 50% of respondents demonstrating awareness, alongside notable gaps in areas such as nanofillers (21.7%) and biosensors (28.3%). Practice levels were generally low, as only 37% reported the availability of nanotechnology devices in their clinics. Gender showed no significant influence on knowledge ($\chi^2 = 0.35$, $p = 0.554$), whereas professional category significantly affected practice, with dental surgeons and therapists exhibiting higher levels than technicians and others ($\chi^2 = 8.92$, $p = 0.012$). Although a significant association existed between knowledge and practice ($\chi^2 = 6.14$, $p = 0.013$), knowledge did not necessarily translate into application. Overall, despite its transformative potential, the adoption of nanodentistry in Nigeria remains limited due to knowledge gaps, inadequate training, financial constraints, and infrastructural challenges [22].

VI. RECOMMENDATIONS

Based on the findings, the following recommendations are made:

1. The Nigerian Dental Association, Ministry of Health, and educational institutions should launch targeted awareness campaigns to educate dental

professionals about nanotechnology and its applications in dentistry [23].

2. Dental education curricula should be revised to include comprehensive training on nanotechnology, its applications, advantages, and safety considerations in dental practice [24].
3. Regular workshops, seminars, and training programs should be organized to update practicing dental professionals on emerging nanotechnology applications [25].
4. Government agencies and dental institutions should invest in nanotechnology infrastructure to make these technologies accessible to dental professionals [26].
5. Institutions like the University of Nigeria Nano Research Group should promote research on nanotechnology applications in dentistry, particularly research focusing on local contexts and resource constraints [27].
6. Regulatory bodies should develop ethical guidelines and safety regulations for the application of nanotechnology in dental practice to address safety concerns and promote acceptance [28].
7. Partnerships between government, academic institutions, and private sector should be established to facilitate the development and distribution of nanotechnology products for dental practice [29].
8. Further studies should be conducted to identify specific barriers to nanotechnology adoption and develop targeted interventions to address these barriers [30].

VII. CONTRIBUTIONS TO KNOWLEDGE

This study provides the first empirical assessment of knowledge and practice of nanodentistry among dental professionals in Onitsha Metropolis, Nigeria. The findings contribute to the growing body of knowledge on nanotechnology adoption in healthcare in developing countries [31] and provide baseline data for future interventions.

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DECLARATION

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