

## Knowledge, Attitude and Perception of Consumers and Stakeholders on Counterfeit Drugs and Anti-Counterfeit Technology in Nigeria

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### Abstract

*The threat of counterfeiting medicines is probably growing, particularly in poorer countries with weak regulatory mechanisms and poorly monitored distribution networks. Various interventions, including innovative technologies, have been used to solve problems. The study used a quantitative design method adopting a hybrid quantitative method such as desk, online and physical interviews approach. The selected states for the study are Lagos, Kano, Anambra and FCT Abuja. Data were obtained using structured questionnaires with mainly closed-ended questions and analysed using SPSS (IBM-SPSS version 21). The findings show that the highest proportion of consumers who have heard about counterfeit or fake drugs before was from Lagos (97.1%). The study also found that stakeholders know highly about fake/counterfeit drugs (94.3%). The results show that 62.0% of consumers knew about drug anti-counterfeiting technology, and most stakeholders (79.0) knew about NAFDAC Anti-Counterfeiting Interventions. However, respondents from Lagos had the highest level of awareness (77.3%) of the Anti-Counterfeiting Interventions. The results also revealed that stakeholders exhibited a positive perception of NAFDAC's innovative techs., (TruScan, RFID, GPHF MINILABS, Black Eye, Others) to curb fake drugs. The findings emphasise raising awareness, implementing effective anti-counterfeiting strategies, and addressing financial limitations to protect public health and combat Nigeria's growing threat of fake drugs.*

**Keywords:** Counterfeiting, Technology, Intervention, KAP, Stakeholder, Consumer.

### Introduction

Counterfeiting medicines is a global phenomenon affecting both developed and less developed or developing countries [1]. There were reports of incidences of counterfeit medicines by developed nations' health organisations such as the US Food and Drug Administration (US-FDA), the European Medicines Agency (EMA) and the UK Medicines and Healthcare Products Regulatory Agency (MHRA) [2]. The World Health Organization, in its report, describes counterfeit medicines as becoming "a global public health crisis" [3]. The threat of counterfeiting

Medicine is probably growing, particularly in poorer countries with weak regulatory mechanisms and poorly monitored distribution networks. The efforts of manufacturers to protect and distinguish their products from fake ones fail in the long run as technologies being employed by counterfeiters surpass theirs [4]. Countries in low and medium-income or developing nations with weak regulatory oversight and law enforcement activities attract illegal manufacturers. In contrast, those with strong regulatory and enforcement repel them, especially as found in developed countries.

Over the years, the Nigerian government has tried to introduce a good healthcare delivery

system, including providing quality, productive and affordable drugs. Through the Federal Ministry of Health (FMOH), the government put intervention programs and policies in place to meet these needs. That led to the establishment of the National Agency for Food and Drug Administration and Control (NAFDAC) on January 1, 1994, as a parastatal of the Federal Ministry of Health [5], [6]. In rising to the challenge of counterfeiting (including food, medicines, and other health products), NAFDAC is working hard to curb the menace of SFs in conjunction and collaboration with the health regulatory authorities of other countries [6]. Various interventions, including innovative technologies, have been used to solve problems. The previous and current Directors General of NAFDAC has introduced many strategies to fight the anti-counterfeiting war [7]. However, the impacts of the various interventions in curbing the influx and circulation of SFs in the country are limited. It is a challenge to meet the national health policy objective of strengthening the national health system such that it will be able to provide effective, efficient, quality, accessible and affordable health services that will improve the health status of Nigerians, which is the target of United Nations' sustainable development goal 3 [8].

Unfortunately, few studies examine how diverse stakeholders in developing countries feel about low-quality and counterfeit drugs. Perhaps this is why anti-drug interventions worldwide tend to focus on the same qualities to persuade consumers not to acquire counterfeit or illegal drugs [9]. However, due to contextual considerations, this may not address the fundamental differences like pharmaceutical counterfeiting between nations at different stages of economic growth. Most consumer-focused research on substandard and counterfeit drugs employs data from the technologically advanced world [9]. There is no indication that consumers from different areas and backgrounds have the same impressions of the problem of substandard and counterfeit pharmaceuticals,

and the problem has grown differently in different locations [9]. As a result, it is critical to understand why people in a certain area purchase counterfeit drugs to devise effective responses.

Hence, the general objective of this study is to assess the knowledge, attitude and perception of consumers and stakeholders on counterfeit drugs and anti-counterfeit technology and interventions in Nigeria.

## **Materials and Methods**

### **Ethical Consideration**

Ethical approval was sought and obtained from the Federal Government Institutional Review Board and the National Health Research Ethics Committee of the National Institute of Medical Research, affiliated with the Federal Ministry of Health. In addition, verbal and written consents were obtained from respondents before administering questions and personal identifiers were removed from summary data. Also, data collected will be securely stored, and the names of individuals were excluded not to identify the individuals and families or groups.

### **Study Design**

The study used a quantitative design method adopting a hybrid quantitative method such as desk review, online and physical interviews approach to ensure all inquiry issues are adequately captured and covered for analysis and specific outputs that address the project's objectives. Using the quantitative approach allowed focusing on a larger sample size to better represent the general population, providing statistical data to support decision- making.

### **Study Area**

The selected states for the study are Lagos, Kano, Anambra and FCT Abuja. Lagos is Africa's largest and former capital city in terms of population, with about 15.3 million people living there. It is also the 4<sup>th</sup> largest economy in Africa. Kano state is the most populous in the

country according to the national census done in 2006, with an estimated 20,000,000 in the year 2020. Anambra state has over 9 million residents in the state based on the 2022 census report.

FCT, Abuja has a population of about 1,693,400, according to the 2022 population estimate.

These states have the highest number of stakeholders due to the highly unregulated open drug markets in these states and the pharmaceutical industry. In contrast, most non-governmental organisations and development agencies involved in pharmaceutical product importation and distribution are located in Abuja.

### Study Population

The study population comprised NAFDAC stakeholders who are dealers in pharmaceutical products or Marketing Authorization Holders (MAHs) of medicines and Consumers. The states are Lagos, Kano, Anambra, and Federal Capital Territory (FCT), with the most stakeholders.

### Sample Size Determination

The sample size was determined using the formulae below to estimate proportions described by Fisher's formula for descriptive studies at normal standard deviation corresponding to a 95% confidence interval (Kasiulevicius, 2006).

For Large Populations (> 10,000)

$$n = \frac{D(Z^2 * pq)}{d^2}$$

Where:

D = design effect, 1.5 will be used.

n = the desired sample size.

Z = the standard normal deviate, usually set at 1.96, which corresponds to the 95% confidence interval.

P = proportion of stakeholders with the right knowledge and practice of the interventions in the study area, because of lack of information from literature, 0.5 will be used.

d = degree of accuracy desired and is set at 5% (0.05).

$$q = 1 - p = 0.5$$

$$n = \frac{1.5(1.96^2 * 0.5(1 - 0.5))}{0.05^2}$$

$$= \frac{1.4406}{0.0025} = 576.24$$

To account for non-responses, the sample size will be increased by 5% to 10 % [10]. This results in 605.052 to 633. 864. Hence a round figure of 635 sample size.

For the quantitative cross-sectional survey, the proportion of stakeholders interviewed represented 20% of the consumer's sample size in each location, which is 127 participants.

### Sampling Technique

A multistage sampling technique was used in drawing the respondents; the total number of stakeholders operating from the selected study area (comprising of groups of Registered Association of Community Pharmacists of Nigeria-ACPN; valid Market Authorization Holders -MAHs of registered drug products obtained from the NAFDAC database; National Association of Industrial Pharmacists-NAIP; Association of Hospital and Administrative Pharmacists-AHAP among others) out of which the desired sample size emerged was selected. Anecdotal reasoning was adopted for sharing ratio between the study centres using the experience of how the stakeholders and pharmaceutical industries are present in those locations [11]. Therefore, based on anecdotal reasoning, a ratio of 3:2:2:1 was adopted for Lagos, Kano, Anambra and FCT Abuja according to the concentration of the pharmaceutical industry, licensed pharmacies, pharmaceuticals importers and NGOs. This multistage sampling is justified because it reduces costs and time associated with data collection and flexibility. It is practical for primary data collection for large populations dispersed geographically.

## **Data Collection**

The Quantitative data were obtained using structured questionnaires with mainly closed-ended questions. A hybrid approach to the interview that included the online distribution of questionnaires (with Google Forms) and personal interviews was adopted. The questionnaires were distributed both online and physically for more harvest of responses. The Google forms were used to distribute those for the stakeholders, while those for consumers were done physically with the assistance of trained assistants at the different locations. The structured questionnaires were designed and categorised into stakeholders (as defined earlier) and general consumers to make it easy to understand. According to the sample size determination, 635 questionnaires were used for the quantitative study. These were shared among the 3 states and FCT Abuja study locations using anecdotal reasoning based on the distribution of the stakeholders and concentration of pharmaceutical industries in these centres. Therefore, using a ratio of 3:2:2:1, 238 questionnaires were shared in Lagos, 159 in Anambra state, 159 in Kano and 79 in FCT Abuja.

## **Outcome Measure**

The outcome measurement of the level of knowledge on the correct use of the various technologies was done through the Scoring of Items under knowledge in the questionnaire. It was used to determine types of knowledge classified as low or high.

## **Pretest of Instrument**

The pretest of the data collection instrument was carried out in Lagos. It was administered to about 10 percent of the study population; the

result was used to fine-tune the questionnaire and get an idea of the areas to improve the proper questionnaire administration.

## **Data Analysis**

For the data analysis technique, the Statistical Package of Social Science (IBM-SPSS version 21) was used to run the analysis after entering the data. Descriptive statistics were generated, i.e., percentages and frequency distribution, to enhance objective and empirical reporting of the findings. Cross tabulations were used to test the hypothesis related to the variables used at a 0.05 significance level.

## **Results**

### **Part A: Consumers**

#### **Demographic Profiles**

Table 1 provides information on the social-demographic characteristics of the study respondents. The largest number of respondents were from Lagos (32.9%), followed by Kano (26.2%), Anambra (24.9%), and Abuja (16.1%). Most respondents were in the age range of 26-35 years (29.1%), followed by 18-25 years (27.3%) and 36-45 years (20.3%). More than half of the respondents were males (55.1%), while female respondents accounted for 44.9% of the total sample. Most respondents were Christians (72.8%), followed by Muslims (24.7%), while traditional religion and no religion had only 1.9% and 0.6% of respondents, respectively. Finally, over half of the respondents (53.5%) had attained tertiary education, while 39.4% had completed only secondary education. The number of respondents with no formal education was very low (1.7%), and only a small percentage had completed primary education (5.4%).

**Table 1.** Social-demographic Parameters of the Study Respondents

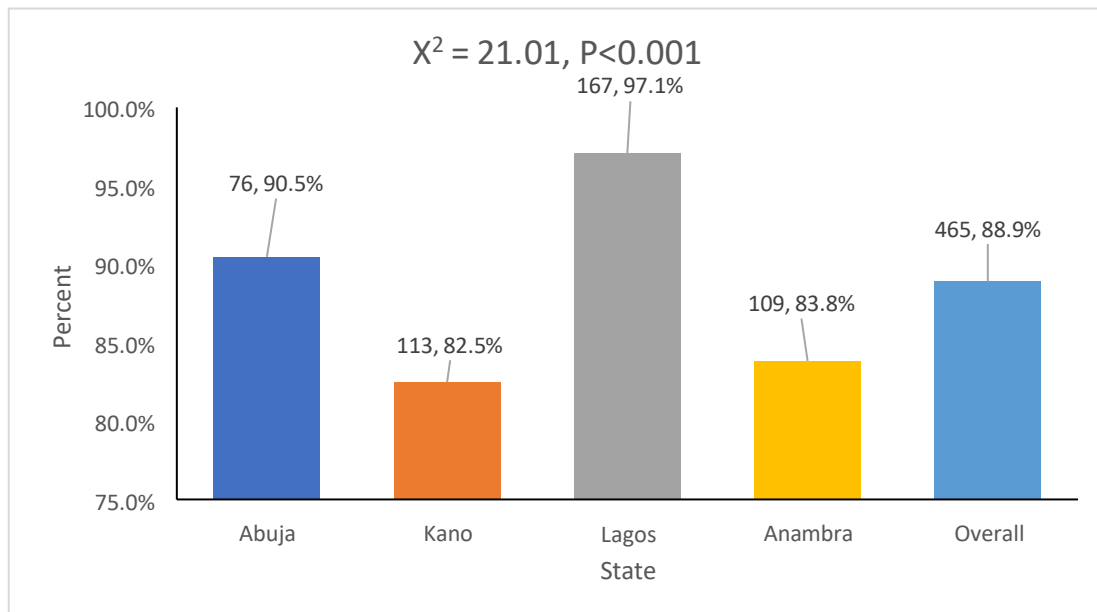
Variables	Parameters	Frequency (n = 523)	Percentage
State	Abuja	84	16.1
	Kano	137	26.2
	Lagos	172	32.9
	Anambra	130	24.9
Age	18 – 25 years	143	27.3
	26 – 35 years	152	29.1
	36 – 45 years	106	20.3
	46 – 55 years	83	15.9
	56 and above	39	7.5
Sex	Female	235	44.9
	Male	288	55.1
Religion	Christianity	381	72.8
	Islam	129	24.7
	Traditional	13	2.5
Marital Status	Single	225	43.0
	Married	278	53.2
	Divorced/Widowed	20	3.8
Educational Attainment	No formal Education	9	1.7
	Primary only	28	5.4
	Secondary only	206	39.4
	Tertiary Education	280	53.5

### Consumer's Knowledge of Substandard and Falsified Drugs

Consumers' knowledge of falsified or substandard drugs was evaluated using three questions, including "Have you ever heard of the counterfeit or fake drug before?", "Have you ever had an incidence of buying a fake drug before?" and "Do you know the underline causes of fake drugs in Nigeria?" Positive answers (Yes) were scored one mark, and No was scored a zero. Consumers that scored 2 of 3 marks were considered knowledgeable, while those who scored less were considered non-knowledgeable.

The percentage of respondents who had previously heard of counterfeit or fake drugs

varies across the four states. The highest proportion of respondents who had heard about counterfeit or fake drugs before was from Lagos (97.1%, n = 167), followed by Abuja (90.5%, n = 76) and Anambra (83.8%, n = 109). In comparison, Kano has the least proportion of awareness (82.5%, n = 113). The chi-square value of 21.01 and p-value less than 0.001 indicates a statistically significant association between the state and awareness of counterfeit or fake drugs. The data suggest that awareness of counterfeit or fake drugs is high among respondents in the surveyed Nigerian states, with a significant difference in awareness levels between states (Figure 1).



**Figure 1.** Respondents Awareness of Fake or Counterfeit Drugs

Table 2 presents a multivariate analysis examining factors associated with consumers' knowledge of fake drugs. The Table is divided into two main categories: poor knowledge and good knowledge, with crude odds ratios (COR) and adjusted odds ratios (AOR) reported alongside their corresponding 95% confidence intervals (CIs) and p-values.

Regarding geographical location, the residents of Abuja were found to have significantly better knowledge about fake drugs than Anambra residents. The AOR for this comparison was 3.28 (95% CI: 1.59–6.75), which is statistically significant at  $P < 0.001$ . In contrast, Kano state residents had significantly worse knowledge than Anambra, with an AOR of 0.43 (95% CI: 0.25–0.75), also significant at  $P = 0.003$ . There were no statistically significant differences between Lagos and Anambra after adjustment for other factors in the model (AOR = 0.94; 95% CI: 0.57–1.57;  $P = 0.823$ ). When

looking at age categories, no significant associations were observed between age groups and knowledge levels after adjusting for other factors in the model. Regarding gender, there were no statistically significant differences between females and males regarding their respective drug knowledge levels (AOR = 1.13; CI: 0.77 - 1.67].  $P = 0.027$ ). No notable

association was seen concerning religion since none passed the significance threshold of  $P < 0.05$ . Similar conclusions can be drawn from marital status as none achieved statistical significance. Lastly, education is critical to consumers' understanding of counterfeit drugs. Those who attained tertiary education had a considerably higher likelihood of having better awareness than individuals without formal schooling—presenting an AOR equal to 12.04 (95% CI: 1.90–76.25;  $P = 0.008$ ).

**Table 2.** Multivariate Analysis of the Factors Associated with Consumers' Knowledge of Fake Drugs

Overall n (%)	Poor knowledge	Good knowledge	COR (95% CI)	P-value	AOR (95% CI)	P-value
	225 (43.0)	298 (57.0)				
State						
Abuja	55 (42.3)	75 (57.7)	2.69 [1.44-5.03]	0.002*	3.28 [1.59 - 6.75]	0.001*
Kano	18 (21.4)	66 (78.6)	0.54 [0.33-0.88]	0.012*	0.43 [0.25 - 0.75]	0.003*
Lagos	79 (57.7)	58 (42.3)	1.00 [0.63-1.58]	0.981*	0.94 [0.57 - 1.57]	0.823*
Anambra	73 (42.4)	99 (57.6)	Ref	-	Ref	-
Age category						
18 - 25	66 (46.2)	77 (53.8)	Ref	-	Ref	-
26 - 35	63 (41.4)	89 (58.6)	1.21 [0.76 - 1.92]	0.416	1.03 [0.59 - 1.78]	0.930
36 - 45	43 (40.6)	63 (59.4)	1.26 [0.76 - 2.09]	0.380	0.85 [0.41 - 1.80]	0.679
46 - 55	38 (45.8)	45 (54.2)	1.02 [0.59 - 1.75]	0.957	1.02 [0.46 - 2.27]	0.959
56 & above	15 (38.5)	24 (61.5)	1.37 [0.67 - 2.830]	0.393	1.38 [0.53 - 3.59]	0.509
Gender						
Male	128 (44.4)	160 (55.6)	Ref	-	Ref	-
Female	97 (41.3)	138 (58.7)	1.42 [0.62 - 1.25]	0.467	1.13 [0.77 - 1.67]	0.527
Religion						
Traditional/Others	9 (69.2)	4 (30.8)	Ref	-		
Christianity	158 (41.5)	223 (58.5)	3.18 [0.96 - 10.49]	0.058	2.86 [0.82 - 9.95]	0.99
Islam	58 (45.0)	71 (55.0)	2.75 [0.81 - 9.40]	0.106	2.11 [0.57 - 7.76]	0.261
Marital status						
Divorced/Widowed	10 (50.0)	10 (50.0)	Ref	-	Ref	-
Single	100 (44.4)	125 (55.6)	1.25 [0.50 - 3.12]	0.633	0.91 [0.29 - 2.79]	0.908
Married	115 (41.4)	163 (58.6)	1.42 [0.57 - 3.52]	0.452	1.23 [0.44 - 3.43]	0.699
Education						
No formal	7 (77.8)	2 (22.2)	Ref	-	Ref	-
Primary	17 (60.7)	11 (39.3)	2.67 [0.40 - 12.97]	0.359	3.13 [0.43 - 22.77]	0.260
Secondary	105 (51.0)	101 (49.0)	3.3.7 [0.68 - 16.59]	0.136	5.38 [0.86 - 33.81]	0.073
Tertiary	96 (34.3)	184 (65.7)	6.71 [1.37 - 32.92]	0.019	12.04 [1.90 - 76.25]	0.008*

\* Significant at p<0.05

## Consumers' Awareness of Drug Anti-counterfeiting Technologies

Table 3 presents the results of consumers' awareness of drug anti-counterfeiting technology. Overall, 62% percent of respondents were aware of drug anti-counterfeiting technology—awareness varied by some factors with statistically significant differences. Respondents from Lagos had the highest level of awareness (77.3%), followed by Abuja (63.1%) and Kano (56.9%), with Anambra having the lowest awareness at 46.2%. After adjusting for other factors in the model using AOR, participants from Lagos were more than four times as likely to be aware compared to those from Anambra (AOR=4.16;  $P<0.001$ ). Similarly, respondents from Abuja were twice as likely to be aware compared to those in Anambra (AOR=2.07;  $P=0.026$ ).

Awareness levels varied across age categories, but no statistically significant differences were observed after adjusting for other factors ( $P>0.05$ ). No statistically significant difference was found between males and females regarding their awareness of drug anti-counterfeiting technology ( $P>0.05$ ). Christians and Muslims both showed significantly higher levels of awareness when compared to traditional/other religions – Christians were nearly six times as likely to be aware (AOR=5.87;  $P=0.017$ ), while Muslims were almost five times as likely (AOR=4.84;  $P=0.041$ ). Divorced/widowed individuals showed significantly higher levels of awareness

compared to single consumers – being over six times more likely to report being aware of such technologies after adjusting for related variables (AOR=6.51;  $P=.006$ ); however, married individuals did not show a statistically significant difference in awareness compared to single individuals.

Consumers with tertiary education were found to have significantly higher levels of awareness than those without formal education. They were almost nine times more likely to report being aware after adjusting for other factors (AOR=8.96;  $P=0.013$ ).

Figure 2 presents the survey results to identify which anti-counterfeiting technologies consumers know. Of all the technologies mentioned, the NAFDAC Registration Number had the highest recognition among respondents, with 287 (54.9%) identifying it as an anti-counterfeiting technology they knew. The second most recognised solution was MAS, chosen by 183 participants, accounting for roughly 35% of all responses. TruScan came in third place, identified by 33 individuals (6.3%). Following TruScan was Hologram, which received recognition from 15 respondents or around 2.9%. Minilab Toolkits were known to approximately 2.5% (13 people), while GPHF garnered slightly less attention at about 1.1%. Black Eye and RFID technologies received lower levels of consumer identification—the former being chosen by just five individuals (1%) and only four participants (0.8%) selecting RFID technology.



**Table 3.** Consumers' Awareness of Drug Anti-counterfeiting Technology

	Not aware	Aware	COR	P-value	AOR	P-value
			(95% CI)		(95% CI)	
Overall n (%)	199 (38.0)	324 (62.0)	-	-	-	-
<b>State</b>						
Abuja	31 (36.9)	53 (63.1)	2.00 [1.14 – 3.50]	0.016	2.07 [1.09 – 3.94]	0.026*
Kano	59 (43.1)	78 (56.9)	1.54 [0.95 – 2.50]	0.079	1.30 [0.75 – 2.25]	0.352
Lagos	39 (22.7)	133 (77.3)	3.98 [2.42 – 6.54]	<0.001*	4.16 [2.42 – 7.16]	<0.001*
Anambra	70 (53.8)	60 (46.2)	Ref	-	Ref	-
<b>Age category</b>						
18 – 25	61 (42.7)	82 (57.3)	Ref	-	Ref	-
26 – 35	57 (37.5)	95 (62.5)	1.24 [0.78 – 1.98]	0.366	1.93 [0.73 – 5.12]	0.184
36 – 45	37 (34.9)	69 (65.1)	1.39 [0.83 – 2.33]	0.216	1.59 [0.67 – 3.76]	0.294
46 – 55	29 (34.9)	54 (65.1)	1.39 [0.79 – 2.43]	0.254	1.41 [0.60 – 3.31]	0.436
56 & above	15 (38.5)	24 (61.5)	1.19 [0.58 – 2.46]	0.638	1.25 [0.84 – 1.97]	0.278
<b>Gender</b>						
Male	108 (37.5)	180 (62.5)	1.05 [0.74 – 1.50]	0.774	1.25 [0.84 – 1.87]	0.278
Female	91 (38.7)	144 (61.3)	Ref	-	Ref	-
<b>Religion</b>						
Christianity	141 (37.0)	240 (63.0)	5.67 [1.53 – 20.96]	0.009*	5.87 [1.37 – 25.26]	0.017*
Islam	48 (37.2)	81 (62.8)	5.63 [1.48 – 21.45]	0.011*	4.84 [1.07 – 21.92]	0.041*
Traditional/Others	10 (76.9)	3 (23.1)	Ref	-	Ref	-
<b>Marital status</b>						
Single	93 (41.3)	132 (58.7)	Ref	-	Ref	-
Married	102 (36.7)	176 (63.3)	1.22 [0.85 – 1.74]	0.288	1.63 [0.91 – 2.92]	0.102
Divorced/Widowed	4 (20.0)	16 (80.0)	2.82 [0.91 – 8.70]	0.072	6.51 [1.69 – 25.05]	0.006*
<b>Education</b>						
No formal	6 (66.7)	3 (33.3)	Ref	-	Ref	-
Primary	16 (57.1)	12 (42.9)	1.50 [0.31 – 7.25]	0.614	1.73 [0.26 – 11.48]	0.572
Secondary	98 (47.6)	108 (52.4)	2.20 [0.54 – 9.05]	0.273	3.71 [0.66 – 20.89]	0.138
Tertiary	199 (38.0)	324 (62.0)	5.09 [1.24 – 20.85]	0.024*	8.96 [1.58 – 50.73]	0.013*

\* Significant at p<0.05

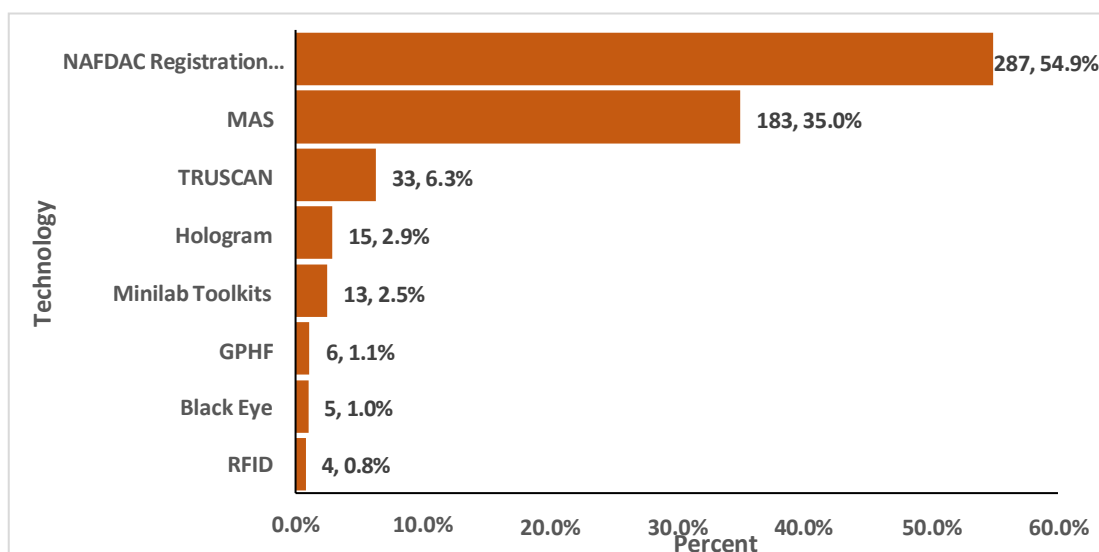


Figure 2. Anti-counterfeiting Technologies Consumers Identified

## Part B: Stakeholders

### Demographic Profiles of the Study Participants who are Stakeholders

Table 4 presents the social-demographic parameters of stakeholders. The data includes 105 individuals, and each variable has several parameters, including frequency and percentage. Lagos has the highest number of stakeholders, 35 (33.3%), followed by Kano at 27 (25.7%), Anambra at 26 (24.8%), and Abuja at 17 (16.2%). The most common age group were 36-

45 years, and 26-35 years, 30(28.6%), followed by 46-55 years, 28 (26.7%), and 56 and above 17 (16.2%). Males constitute most stakeholders, 69 (65.7%) and 36 (34.3%). Christianity is the most common religion among stakeholders 79 (75.2%), followed by Islam 26 (24.8%). More than half of the stakeholders were married, 81 (77.1%), followed by 21 single (20%). Almost all stakeholders, 101 (96.2%), have Tertiary Education, while only 4 individuals (3.8%) have Secondary education. The most common ethnicity is Igbo, 46 (43.8%), followed by Yoruba, 29 (27.6%), and only 7 Hausa (6.7%).

Table 4. Social-demographic Parameters of Stakeholders

Variables	Parameters	Frequency (n = 105)	Percentage
State	Abuja	17	16.2
	Kano	27	25.7
	Lagos	35	33.3
	Anambra	26	24.8
Age	26 – 35 years	30	28.6
	36 – 45 years	30	28.6
	46 – 55 years	28	26.7
	56 and above	17	16.2
Sex	Male	69	65.7
	Female	36	34.3
Religion	Christianity	79	75.2
	Islam	26	24.8
Marital Status	Single	21	20.0
	Married	81	77.4
	Divorced/Widowed	3	2.9

	Widowed	1	0.9
Educational Attainment	Secondary only	4	3.8
	Tertiary Education	101	96.2
Ethnicity	Hausa	7	6.7
	Igbo	46	43.8
	Yoruba	29	27.6
	Others	23	21.9

### Stakeholders' Awareness of Fake Drugs

Stakeholders' knowledge of fake drugs was determined with four questions: "Can you differentiate between genuine and counterfeited drugs," "Have you heard of or had an encounter with fake drugs in circulation?" "Do you know where to report the incidence of fake drugs?" and "Do you know the underlying causes of fake drugs in Nigeria?" Positive answers (Yes) were scored one mark, and "No" was scored a zero. Stakeholders who scored three or higher were considered to have good knowledge, while those who scored less had poor knowledge of fake drugs. Table 5 presents a detailed overview of stakeholders' knowledge of drug counterfeiting and fake drugs across four states in Nigeria. A total of 79 participants (75.2%) could effectively distinguish between authentic and counterfeited drugs. Specifically, 82.4% were from Abuja; all respondents from Kano demonstrated this ability (100%), while only 68.6% from Lagos and 53.8% from Anambra also exhibited this competency. The Chi-Square test indicates a significant difference between these groups at the p-value <0.001. Most participants have heard about or encountered counterfeit medicines in

circulation - around 92 individuals or an estimated prevalence rate of over four-fifths (87%). There is no statistically significant variation among studied regions regarding encountering such products since they each reported 82-88% high rates. Knowing where to report instances involving forged medications: Most participants—102 out of the total number—who took part claimed cognisance regarding places for reporting incidents linked to falsified medicinal substances; findings highlighted increased understanding across nearly all regions studied except for Lagos state presenting lower results compared with another three Nigerian states included herein. Knowledge about underlying causes behind drug counterfeiting within Nigeria's territory remains high amongst surveyed stakeholders totaling up towards nine-tenths' tallied responses (86%). Lastly, 99 participants (94.3%) showed a high knowledge of the subject matter. Out of this total portion, 100% were from Abuja and Kano, 88.6% were from Lagos, and 92.3% belonged to Anambra state. However, the Chi-Square test shows that differences between these groups are not statistically significant, with a p-value of 0.174.

**Table 5.** Stakeholders' Knowledge of Drug Fake/Counterfeiting

Parameter	Total (n = 105)	STATE n (%)				Chi-Square (P-value)
		Abuja (n = 17)	Kano (n = 27)	Lagos (n = 35)	Anambra (n = 26)	
Can differentiate between genuine and counterfeited drugs	79 (75.2)	14 (82.4)	27 (100.0)	24 (68.6)	14 (53.8)	16.569 (0.001*)
Have you heard of or had an encounter with	92 (87.6)	14 (82.4)	24 (88.9)	31(88.6)	23 (88.5)	0.521 (0.914)

fake drugs in circulation						
Knows where to report the incidence of fake drugs	102 (97.1)	17 (100.0)	27 (100.0)	32 (91.4)	26 (100.0)	6.176 (0.103)
Know the underline causes of fake drugs in Nigeria	92 (87.6)	17 (100.0)	25 (92.6)	30 (85.7)	20 (76.9)	5.877 (0.118)
Overall good knowledge	99 (94.3)	17 (100.0)	27 (100.0)	31 (88.6)	24 (92.3)	4.977 (0.174)

\*values are significantly different at the 0.05 level

### Stakeholders' Awareness of NAFDAC Anti-Counterfeiting Interventions

As shown in Table 6, most (80%) respondents have heard of drug anti-counterfeiting technology. There is no statistically significant difference between states ( $P=0.080$ ). Also, 33.3% of respondents have experienced using an anti-counterfeiting device that confirmed a drug as fake; no statistically significant difference between states ( $P=0.401$ ). Awareness about the TruScan spectrometer is at 48.6%, with a highly significant difference between states ( $P<0.001$ ). Knowledge about GPHF minilab kits for drug counterfeiting detection stands at 27.6%. A significant difference exists between states in this regard ( $P=0.005$ ).

The Black Eye devices are known by 34.3% of participants, presenting a highly significant difference between their awareness levels across states ( $P<0.001$ ). Radiofrequency Identification devices (RFID) are familiar to 38.1% of respondents; results show that such knowledge significantly differs among surveyed locations ( $P=0.048$ ). There was high-level familiarity with WHO prequalification requirements for drug registration (89.5%), while no notable differences exist amongst different areas ( $P=0.440$ ). Knowledge of Quality Management Systems (QMS) and ISO certification incorporated into NAFDAC processes scores at 84.8%, displaying substantial distinction within respective regions ( $P=0.005$ ).

NAFDAC drug laboratories are recognised as WHO-ISO 17025 compliant by 92.4% of stakeholders, with significant differences between states ( $P=0.043$ ). Awareness of NAFDAC blacklisting foreign pharmaceutical companies for noncompliance sits at 81.9%. This awareness has a statistically significant difference among the states ( $P=0.003$ ). Knowledge regarding NAFDAC appointing Analysts/Inspection agents in India and China to report on drug quality before shipment to Nigeria is present in 54.3% of stakeholders; a highly significant discrepancy is apparent among states ( $P<0.001$ ). Online registration (NAPAMS) and clearing of drugs (PIDCARMS) enhancing effective monitoring and control of drug quality has been acknowledged by 65.4% of respondents, whereas substantial statistical variations can be observed in diverse locations ( $P=0.004$ ).

**Table 6.** Stakeholders' Awareness of NAFDAC Anti-Counterfeiting Interventions

Parameter	Total (n = 105)	STATE n (%)				Chi-Square (P-value)
		Abuja (n = 17)	Kano (n = 27)	Lagos (n = 35)	Anambra (n = 26)	
Have you ever heard of drug anti-counterfeiting technology?	84 (80.0)	17 (100.0)	19 (70.4)	29 (82.9)	19 (73.1)	6.772 (0.080)
Have you ever had a situation where the use of anti-counterfeiting devices confirms a drug to be fake	32 (33.3)	6 (35.3)	5 (27.8)	15 (42.9)	6 (23.1)	2.939 (0.401)
Have you heard of the TruScan spectrometer (handheld device) for on-the-spot detection of counterfeit medicines?	51 (48.6)	14 (82.4)	8 (29.6)	22 (62.9)	7 (26.9)	19.382 (<0.001*)
Have you heard of GPHF (global pharma health fund) minilab kits for drug counterfeiting detection?	29 (27.6)	10 (58.8)	5 (18.5)	11 (31.4)	3 (11.5)	13.016 (0.005*)
Have you heard of Black Eye (Infra-Red) devices for speedy evaluation of medicines quality?	36 (34.3)	4 (23.5)	18 (66.7)	10 (28.6)	4 (15.4)	18.066 (<0.001*)
Do you know of a Radiofrequency Identification device (RFID) to verify regulated products, including drugs?	40 (38.1)	6 (35.3)	10 (37.0)	19 (54.3)	5 (19.2)	7.883 (0.048*)
Are you aware of the WHO- Prequalification requirement for drug registration?	94 (89.5)	17 (100.0)	24 (88.9)	31 (88.6)	22 (84.6)	2.703 (0.440)
Are you aware of the introduction of Quality Management Systems (QMS) and ISO certification into NAFDAC processes?	89 (84.8)	14 (82.4)	27 (100.0)	31 (88.6)	17 (65.4)	12.882 (0.005*)
Do you know that NAFDAC drug laboratories are certified by WHO and ISO 17025 compliant?	97 (92.4)	17 (100.0)	27 (100.0)	29 (82.9)	24 (92.3)	8.139 (0.043*)
Are you aware that NAFDAC blacklisted some foreign pharmaceutical manufacturing companies for noncompliance with regulations?	86 (81.9)	17 (100.0)	21 (77.8)	23 (65.7)	25 (96.2)	13.818 (0.003*)
Do you know that NAFDAC appointed some Analysts/Inspection agents in India and China to report on drug quality before shipment to Nigeria?	57 (54.3)	17 (100.0)	6 (22.2)	21 (60.0)	13 (50.0)	26.154 (<0.001*)
Has the Online registration process (NAPAMS) and clearing of drugs (PIDCARMS) enhanced effective monitoring and control of drug quality?	68 (65.4)	17 (100.0)	18 (66.7)	21 (61.8)	12 (46.2)	13.466 (0.004)
Overall stakeholders with good knowledge	83 (79.0)	17 (100.0)	24 (68.6)	24 (68.6)	18 (69.2)	9.917

\*Values are significantly different at the 0.05 level

## Stakeholders' Perception of NAFDAC Innovative Techs., (TruScan, RFID, GPHF MINILABS, Black Eye, Others) to Curb Fake Drugs

Table 7 shows stakeholders' perception of NAFDAC's innovative technologies, such as TruScan, RFID, GPHF MINILABS, Black Eye, and Others, to curb fake drugs in different locations in Nigeria.

Stakeholders in all locations agreed with NAFDAC's deployment of anti-counterfeiting technologies, with mean scores ranging from 4.11 to 4.29. However, there were no statistically significant differences in perception among the locations ( $P= 0.551$ ).

Stakeholders generally perceived that stakeholder groups are important to work with the National Regulatory Authority to prevent the influx of substandard and falsified (SFs) drugs into Nigeria, with mean scores ranging from 4.48 to 4.99. However, the p-value ( $P= 0.058$ ) suggests that there may be some variability in perception among the locations, although not statistically significant at the 0.05 level. Stakeholders generally perceived that they play critical roles in implementing interventions to curb fake drugs, with mean scores ranging from 4.53 to 4.81. However, there were no statistically significant differences in perception among the locations ( $P= 0.250$ ).

Stakeholders generally perceived that the anti-counterfeiting technologies, such as a hologram, RFID, NRN, MAS, manufacturing, and expiration dates, are important to them

dispensing/purchase decision, with mean scores ranging from 3.58 to 4.29. However, the p-value ( $P= 0.112$ ) suggests that there may be some variability in perception among the locations, although not statistically significant at the 0.05 level. Stakeholders generally perceived that drugs could still be imported, distributed, sold, or purchased without anti-counterfeiting devices, even after fully implementing the technologies, with mean scores ranging from 2.26 to 3.30. However, the p-value ( $P= 0.177$ ) suggests that there may be some variability in perception among the locations, although not statistically significant at the 0.05 level.

Stakeholders generally perceived that NAFDAC interventions and anti-counterfeiting technologies have not effectively reduced the rate of counterfeiting drugs in Nigeria, with mean scores ranging from 2.88 to 3.26. However, there were no statistically significant differences in perception among the locations ( $P= 0.663$ ). Stakeholders generally perceived that the level of awareness of NAFDAC interventions to detect fake drugs is insufficient, with mean scores ranging from 3.04 to 3.76. However, the p-value ( $P= 0.071$ ) suggests that there may be some variability in perception among the locations, although not statistically significant at the 0.05 level. Stakeholders generally perceived that regulatory methods in detecting fake drugs have been moderately effective, with mean scores ranging from 2.86 to 3.24. However, there were no statistically significant differences in perception.

**Table 7.** Stakeholders' Perception of NAFDAC Innovative Techs., (TruScan, RFID, GPHF MINILABS, Black Eye, Others) to Curb Fake Drugs

Perception	Location (Mean±SD)					
	Abuja	Kano	Lagos	Anambra	Total	P-value
	(n = 17)	(n = 27)	(n = 35)	(n = 26)	(n = 105)	
How much do you agree with NAFDAC's deployment of anti-counterfeiting technologies?	4.29±0.85	4.26±0.76	4.11±0.90	3.96±0.93	4.15±0.86	0.551
Stakeholder groups are necessary to work with	4.99±0.01	4.67±0.68	4.63±0.65	4.48±0.65	4.66±0.62	0.058

National Regulatory Authority to prevent the influx of SFs into Nigeria						
Stakeholders play critical roles in the implementation of the interventions	4.53±0.51	4.81±0.40	4.66±0.54	4.56±0.65	4.65±0.54	0.250
These technologies are NOT serving the desired purpose of detecting fake drugs	2.94±0.66	3.25±1.19	3.36±1.11	3.20±1.26	3.22±1.10	0.649
Hologram, RFID, NRN, MAS, Mfg. & Exp. Dates etc., are NOT IMPORTANT to your dispensing/purchase decision	4.29±1.31	3.58±1.38	3.64±1.25	4.22±1.04	3.88±1.27	0.112
You can still import/distribute/sell/buy drugs without the anti-counterfeiting device, even after full implementation of the technology	2.41±1.42	3.30±1.64	2.26±1.39	3.16±1.55	3.14±1.52	0.177
NAFDAC interventions and the use of anti-counterfeiting technologies HAVE NOT reduced the rate of counterfeiting drugs in Nige	3.12±1.27	2.93±1.44	3.26±1.26	2.88±1.30	3.06±1.31	0.663
Do you agree that the level of awareness on NAFDAC Interventions to detect fake drugs is enough	3.76±0.44 <sup>b</sup>	3.04±1.45 <sup>a</sup>	3.20±1.18 <sup>ab</sup>	3.74±1.10 <sup>ab</sup>	3.37±1.19	0.071
Regulatory methods in detecting fake drugs have been so effective	3.24±0.75	3.07±1.00	2.86±1.06	3.13±1.52	3.04±1.12	0.658
Overall perception	3.73±0.60	3.67±0.58	3.67±0.55	3.65±0.64	3.68±0.58	0.979

The mean of locations with the same superscript alphabets are not significantly different at  $P < 0.05$ ; \*The mean difference is significant at the 0.05 level

## Discussion

Counterfeit medicines pose a considerable threat to a population's health and economic aspects. It is a global problem in almost all

developing and developed countries [12]. In many cases, they are dangerous and detrimental to public health regarding human suffering and burden on health services [13]. This section discusses the findings from the result of this

study, compares the findings with other studies and provides recommendations.

### **Consumers' and Stakeholders' Knowledge of Substandard and Falsified Drugs**

This study's findings show that the highest proportion of consumers who have heard about counterfeit or fake drugs before was from Lagos (97.1%), followed by Abuja (90.5%) and Anambra (83.8%). In comparison, Kano has the least proportion (82.5%). This study also found that stakeholders know highly about fake/counterfeit drugs (94.3%). This shows that most consumers and stakeholders in this study know about fake drugs. This was consistent with a study by Onuh et al. (2022) [14] on assessing consumers' awareness and ability to identify counterfeit drugs in developing African countries, which found a high awareness of fake drugs in Nigeria. The same study found a low level of awareness among participants in Ghana and Pakistan. This study's findings were also in consonant with another study by Mhando et al. (2016) [15] which found that most respondents knew about fake drugs.

The possible reasons for the high level of knowledge of fake drugs among consumers and stakeholders in this study could be because NAFDAC has placed great emphasis on mobilizing the public in the war against substandard, fake/counterfeit drugs and food products in the country. In this regard, the Agency initiated national mass media health communication campaigns on producing, selling, and consuming quality food products and genuine medication drugs [16]. Communication campaigns are intended to generate specific outcomes for a relatively large number of individuals within a specified time and through an organised set of communication activities [17].

This study reveals that most consumers know the factors associated with fake drugs. Also, the study indicates that geographical location and educational attainment are significantly

associated with consumers' knowledge of fake drugs. In particular, Abuja residents had better awareness than Anambra residents, whereas Kano state residents fared worse. Tertiary-educated individuals were also more likely to understand counterfeit drugs better than those without formal education. However, age, gender, religion, and marital status did not significantly affect consumers' drug knowledge levels of fake drugs.

### **Consumers' and Stakeholders' Awareness of Drug Anti-Counterfeiting Technology**

This study finding shows that 62.0% of consumers were aware of drug anti-counterfeiting technology. However, respondents from Lagos had the highest level of awareness (77.3%), followed by Abuja (63.1%) and Kano (56.9%), with Anambra having the lowest awareness at 46.2%. This shows that many are aware of anti-counterfeiting technology in Nigeria.

This study also revealed that most stakeholders (79.0) knew NAFDAC Anti-Counterfeiting Interventions. However, stakeholders from Abuja (100%) were more aware than those from the other three states under review in this study. This study's findings contradict Uzochukwu Elizabeth's [18] findings on audience awareness and mobile authentication service (MAS) use in identifying fake and substandard drugs in Nigeria.

The study found that most respondents were unaware of NAFDAC's Mobile Authentication Service. The possible reasons why most participants in this study are aware of anti-counterfeiting technology could be because the Nigerian government and pharmaceutical industry have taken steps to educate the public about the dangers of counterfeit drugs and the importance of using anti-counterfeiting technologies [19]. This includes campaigns to raise awareness and implement measures such as serialisation, which involves assigning a unique code to each drug package for traceability



purposes. Also, cases of counterfeit drugs and their harmful effects have been widely reported in the Nigerian media, raising public awareness of the issue. This has increased public concern about the issue and demand for solutions such as anti-counterfeiting technologies. With the widespread availability of information on the internet and social media, consumers are more empowered to educate themselves about issues such as counterfeit drugs and the technologies available to combat them.

The need for sophisticated anti-counterfeit technology is ever-growing as the practices of counterfeiters become increasingly advanced. Technology as a countermeasure must necessarily improve, especially in reaction to a multifarious problem.

There is a manufacturing concern to ensure brand protection and reinforce intellectual property rights for pharmaceutical companies and health concerns, with counterfeit drugs potentially leading to mortality. A counterfeit medicine's content is often substandard, containing fewer or no active ingredients or incorrect measures, and it can contain contaminants or inappropriate excipients. This results in the possibility of treatment failure or death [20].

Counterfeit drugs can lead to drug recalls and liability suits. In addition, brand loyalty is compromised as consumers perceive additional risks when using a company's products. An effective anti-counterfeit strategy avoids this and ensures patient safety [21]. Implementing anti-counterfeit technologies is a prominent preventive measure [21].

In addition to providing authentication, they make producing a convincing copy of a drug more difficult and costly [22]. By employing these technologies, government authorities may ensure that drugs in the supply chain are legitimate. For example, the US Prescription Drug Marketing Act of 1987 (PDMA), amended by the Prescription Drug Amendments of 1992 (PDA), requires wholesalers to provide a

pedigree before each wholesale distribution of prescription drugs [22].

### **Stakeholders' Perceptions of NAFDAC's Anti-counterfeiting Innovative Technologies**

The result from this study also revealed that stakeholders exhibited a positive perception of NAFDAC's innovative techs., (TruScan, RFID, GPHF MINILABS, Black Eye, Others) to curb fake drugs. This may be because NAFDAC's innovative technologies have demonstrated their effectiveness in detecting and combating fake drugs [7]. Stakeholders have seen positive results in identifying counterfeit medications and preventing their distribution in the market. This success may have bolstered their confidence in these technologies. Also, implementing these innovative technologies may have provided stakeholders with additional protection. They feel reassured knowing that NAFDAC is actively using advanced tools to ensure the authenticity and quality of medications in the market. This helps instill trust in the regulatory system and healthcare ecosystem. And lastly, NAFDAC may have been actively educating the public about the dangers of fake drugs and the importance of using authentic medications [22]. As part of their campaigns, the promotion and communication of these innovative technologies have helped raise awareness and educate consumers about their role.

### **Limitation**

The study focuses on four Nigerian states: Lagos, Abuja, Anambra, and Kano. While these states may give useful information, they may not be totally representative of the country. The findings may not apply to other regions or rural areas with varying socioeconomic situations and healthcare facilities.

Furthermore, the study is based on self-reported data from customers and stakeholders. Recall bias, social desirability bias, and participants' subjective interpretations of the questions can all have an impact on self-reported

statistics. These biases can have an impact on the findings' accuracy and dependability.

## Summary

According to the findings of the research, consumers and stakeholders in Nigeria have a high degree of knowledge and awareness regarding counterfeit pharmaceuticals. Lagos has the greatest level of consciousness, followed by Abuja and Anambra. Anti-counterfeiting technology is also known to consumers in these locations.

Stakeholders see NAFDAC's innovative technologies positively since they have demonstrated success in identifying and combating counterfeit medications. This awareness has been aided by public education initiatives and government efforts, as well as media coverage and internet accessibility. Implementing modern anti-counterfeit technology is critical for dealing with counterfeiters' developing practises and ensuring patient safety.

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## Conclusion

This study assesses consumers' and stakeholders' knowledge, attitude and perception of counterfeit drugs and anti-counterfeit technology and interventions in Nigeria. Consumers demonstrate awareness of the factors associated with counterfeit drugs and positively perceive NAFDAC's anti-counterfeiting strategies.

Stakeholders generally hold positive perceptions of NAFDAC's interventions and innovative technologies. The findings emphasise raising awareness, implementing effective anti-counterfeiting strategies, and addressing financial limitations to protect public health and combat Nigeria's growing threat of fake drug.

## Conflict of Interest

The author declares no conflict of interest.

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