



Perceived Benefits of Using Smart Lockers as Virtual Dispensing Units for Chronic Disease Medication: Healthcare Workers' and Patients' Perspective

Ibrahim Bola Gobir

ORCID: 0000-0002-3640-7772

Center for Global Health Practice and Impact,
Georgetown University, Washington DC, United States of America

Mercy Piring'ar Niyang

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Helen Adamu

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Samson Agboola

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Azeez Akanbi Bello

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Nnadozie Onyinyechi Havila

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Fatimah Ohunene Sanni

Georgetown Global Health Nigeria,
Federal Capital Territory, Abuja, Nigeria

Suzzy Angmun Otubo

Savannah Health System Innovation Limited,
Federal Capital Territory, Abuja, Nigeria

Deus Bazira

Center for Global Health Practice and Impact,
Georgetown University, Washington DC, United States of America

ABSTRACT

Chronic diseases present a significant public health challenge globally, particularly in resource-limited settings like Nigeria. Effective management of chronic diseases often requires regular access to medications and adherence to treatment regimens. Smart Lockers, serving as Virtual Dispensing Units (VDU), offer a potential solution to improve medication access and adherence among individuals with chronic illnesses. However, little is known about the perceptions of healthcare workers (HCWs) and patients regarding using Smart Lockers in Nigeria. This study assessed the perceived benefits of Smart Lockers as VDU among HCWs and patients for chronic disease medications. It explored how demographic factors influence these perceptions. A descriptive cross-sectional research design was employed. Data were collected from 405 HCWs and 728 patients via a structured questionnaire. Descriptive statistics were used to analyze demographic characteristics and perceived benefits, including means, standard deviations, and percentages. Additionally, One-way Analysis of Variance (ANOVA) and t-test were conducted to explore relationships between demographics and perceptions, with significance set at $p < 0.05$. The results revealed that among HCWs, the perceived benefits of Smart Lockers included reduced workload (Mean = 4.40), facility decongestion (Mean = 4.50), and decreased patient waiting time (Mean = 4.57). Patients perceived benefits such as minimization of time spent waiting at healthcare facilities (Mean = 4.26) and reduced transportation costs associated with accessing care (Mean = 3.84) most positively. Significant variations in perceptions among HCWs and patients were observed based on demographic factors such as gender, age, marital status, employment status, and educational qualification. Male HCWs and patients, as well as employed patients, tended to perceive the benefits of Smart Lockers more positively compared to their female counterparts and unemployed patients, respectively ($p < 0.05$). Additionally, patients with higher educational qualifications expressed more favourable perceptions of Smart Locker's benefits than those with lower educational levels ($p < 0.05$). Understanding these perceptions and demographic influences is crucial for effectively implementing and utilizing Smart Lockers technology in healthcare settings. Tailored interventions based on these findings can help address disparities in perceptions and enhance the acceptance and utilization of Smart Lockers for chronic disease management in Nigeria. This study provides significant perspectives into healthcare technology and chronic disease management, ultimately aiming to improve healthcare delivery and patient outcomes in Nigeria.

Keywords: Smart Lockers, Chronic diseases, Healthcare workers, Medication, Persons Living with HIV (PLHIV), Virtual dispensing units (VDU).

BACKGROUND

Traditional care methods for chronic diseases have involved in-person visits to healthcare facilities and healthcare providers' offices. Often, patients seek out healthcare providers for clinical consultations, diagnoses, prescriptions, refills, and even routine health status monitoring done in person. This approach strains HCWs who must attend to many patients daily, particularly in settings where resources are strained.^[1] Recently, the trend has attempted to shift the focus of healthcare service delivery from providers to patients. There has been increased advocacy for incorporating decentralized and person-centred care in health systems.^[2] The potential for innovation to improve the quality of care and service delivery in healthcare is enormous, be it a new concept, product, service, or care pathway that offers clear

advantages over current practices.^[3,4] However, if it must be considered a successful innovation, it should be usable and appealing to the target population. Globally, efforts to improve the quality of healthcare services are hampered by insufficient budgets, an increase in demand, and public expectations ^[5,6]. This is important in achieving equitable access to healthcare. The role of technology in enabling person-centred care cannot be underestimated. Progress is being made in medicine and information, with communication technology driving the digitalization of healthcare systems.^[7,8] Digital health technologies offer significant opportunities in this new era of healthcare digitalization to maximize clinical care delivery and clinical research.^[9] In addition, patients are more involved as healthcare becomes increasingly digital. Consequently, digital healthcare solutions have become critical to keeping up with the growing number of empowered patients making medical decisions.^[10]

For example, the South African National Blood Service (SANBS) began using drones to distribute blood to combat the continent's high maternal mortality rate. This has allowed access to life-saving health services within as few as 30 minutes compared to previously obtainable using road transport, which may take days.^[11] Other technological innovations include mobile apps that offer remote access to medical information and even clinical consultations. In Nigeria, "Omomi," an app for pregnant women, advises mothers, intending and expectant mothers, on how to keep track of their child's health.^[12] Similarly, a malaria-diagnosing app is undergoing clinical trials in Uganda.^[13]

Several methods of dispensing medications to patients have been explored at different times. For instance, A study conducted in Zimbabwe describes various community-based and facility-based care models for the dispensing of ARV drugs. The study reported decentralizing services to primary health care centres where patients can access drug pickups is a facility-based model. In contrast, the community-based model requires patients to pick up their medications near their residences, such as community-based organizations, malls, or community halls.^[14]

The outbreak of the COVID-19 pandemic brought to bear the significance of telehealth innovations in providing decentralized and person-centred care. In many countries, there was increased adoption and rapid expansion of telehealth services.^[4,15] In South Africa, for instance, an innovative method of drug distribution to chronic disease patients was used during the Coronavirus outbreak. Drugs were prepackaged and delivered to the homes to reduce the frequency of hospital visits and exposure to COVID-19 infections.^[16]

Another innovation is the Pharmacy Dispensing Unit (PDU), a remote dispensing unit with similar features to an Automated Teller Machine. It uses robotic technology to deliver medication on demand and allows pharmacist consultation via audio video.^[17] Similar to the PDU is the Smart Lockers, an automated medication delivery machine. It has been used to dispense chronic disease medications such as Antiretrovirals (ARVs) and Tuberculosis (TB). De Villers ^[18] described using Smart Lockers strategically placed in accessible locations such as clinics, retail malls, pharmacies, or bus stops. To get their medication, patients can use their cell phones to access a one-time password to unlock a compartment in the locker where their drugs have been pre-dispensed by trained personnel. In South Africa, Smart Lockers have been documented in dispensing ARVs and Tuberculosis (TB) medications, which allowed patients to access prescribed drugs within minutes using an automated one-time password to access the locker.^[18] This innovation has been regarded as a massive breakthrough in the healthcare

system, cutting down on waiting time from 3 to 4 hours to about 3 minutes or less and a paradigm shift from missing out on work, thereby losing money. The Smart Lockers allow the HCWs and patients 24-hour access.^[18]

The unpleasant experience of patients in long queues at the hospitals, endless waiting times for drug pickup, and unnecessary burdens on HCWs and facilities have been addressed using Smart Lockers or Parcel Lockers. Moreover, using Smart Lockers has helped HCWs focus more on patients with critical conditions than on stable patients who need regular medications to manage their conditions. Standell ^[19] and Quadient ^[20] asserted that beyond medication dispensing, healthcare professionals and health facilities could use Smart Lockers as a means of collecting and dropping off test kits and reducing person-to-person contact, especially in this era of infectious diseases like coronavirus.^[20] To mitigate the impact of future pandemic outbreaks, such as COVID-19, virtual healthcare services should include Smart Lockers.^[21]

Smart Lockers have been found to have significant positive effects in countries where they have been deployed. ^[19,20] However, no known study has explored the perceptions of HCWs and patients on the benefits of using Smart Lockers or other virtual dispensing units (VDU) for healthcare delivery in Nigeria. This study, therefore, assessed the perceived benefits of Smart Lockers as VDU among HCWs and Patients for chronic disease medications and explored how demographic factors influence these perceptions.

Research Question

What are the benefits of Smart Lockers as VDU from the perspectives of healthcare workers and patients with chronic diseases?

METHODS

Study Design and Setting

We conducted a cross-sectional study to assess the perceived benefits of Smart Lockers as VDU for chronic disease medication among HCWs and patients in Nigeria. The study took place between November 8th and December 4th, 2021, across secondary healthcare facilities in five states: Adamawa, Akwa Ibom, Cross River, Benue, and Niger.

These healthcare facilities were selected based on their specialization in providing care for patients with chronic diseases such as Diabetes, Hypertension, HIV, Cancer, and Tuberculosis, among others. Identification of these facilities was facilitated through collaboration with Implementing Partners supporting clinical care initiatives in these states.

Study Population

The target populations for this study encompass two main groups:

1. **Healthcare Workers:** This group includes healthcare professionals who provide medical care and services to individuals with chronic diseases.
2. **Persons Living with Chronic Illnesses:** This group comprises individuals who have been diagnosed with one or more chronic diseases such as HIV, Diabetes, Hypertension, chronic kidney disease, Cancer, TB, etc.

Inclusion Criteria

1. People aged 18 years or above who have a chronic disease that necessitates regular medication refills, such as HIV, Diabetes, Hypertension, chronic kidney disease, Cancer, TB, etc., and receive care in the facilities listed in the Appendix.
2. HCWs for chronically ill individuals from the facilities listed in the Appendix.

Sample Size Determination

Healthcare workers (HCWs):

According to a research paper on the health workforce estimated between 2016 and 2030 to understand if Nigeria will have enough workforce,^[22] the estimated number of HCWs was 621,205. This was used as a proxy for HCWs caring for chronic illness patients. This was inputted into the Raosoft sample size calculator at a 5% margin of error, 95% confidence interval, and 50% response distribution to yield a minimum sample size of 384.

Patients of Persons Living with Chronic Illnesses:

According to a research paper on patterns of chronic illnesses conducted in Nigeria in 2020,^[23] the percentage of chronic diseases in Nigeria is about 64.9% of the population. This was used as a proxy to estimate the prevalence of chronic diseases, given that the population of Nigeria is about 200 million.^[24] This was entered into the Raosoft sample size calculator at a 4% margin of error, 95% confidence interval, and 50% response distribution to yield a minimum sample size of 601.

Selection of Participants

HCWs providing chronic disease care and patients with chronic illnesses were identified through the selected healthcare facilities in the respective states. Stratified random sampling was used to identify patients with chronic illness and HCWs who meet the inclusion criteria. The participants were stratified based on gender, i.e., 50% male and 50% female, to ensure adequate representation.

Data Collection

Data collection involved the administration of a semi-structured questionnaire to HCWs and patients living with chronic diseases. The questionnaire comprised 37 items and was designed to gather information on sociodemographic characteristics, perceptions of Smart Lockers as VDU for chronic disease medication, and other relevant factors.

Participants were first provided information about the survey's objectives and were required to consent before completing the questionnaire. The questionnaire included a section on sociodemographic characteristics, covering gender, age, marital status, employment status, and highest educational qualification.

Furthermore, the questionnaire included 9 benefits to assess the perceived benefits of using Smart Lockers as VDU for medication dispensing among HCWs and 3 benefits to assess the perceived benefits among patients. Responses were recorded on a 5-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5), allowing participants to express their level of agreement or disagreement with the statements presented. No personally identifiable data was collected from the participants.

Statistical Analysis

The data were analyzed using descriptive statistics, including frequencies, percentages, mean values, and standard deviation. Statistical mean scores were utilized to measure healthcare workers' and patients' perceptions of the perceived benefits of the Smart Lockers as VDU for chronic disease medications. To further explore the relationship between demographic characteristics and the perceived Smart Lockers' benefits, One-way Analysis of Variance (ANOVA) and t-test were employed. The significance level was $p < 0.05$, with a 95% confidence interval as a threshold for determining statistically significant findings. The IBM Statistical Product and Service Solutions (SPSS) software, version 25, was employed for the analysis to generate robust findings from the data.

Ethical Considerations

Informed Consent:

Participants were provided with detailed information regarding the study objectives, eligibility criteria, data privacy measures, and researchers' disclaimers on the entry page of the survey. Informed consent was obtained from all participants before proceeding with the survey. Consent was indicated by ticking the "I agree" checkbox on the survey, indicating the participant's voluntary agreement to participate in the study. Entries from participants who did not meet the inclusion criteria were not processed for data analysis, ensuring that only eligible participants' data were included.

Confidentiality:

To uphold participant confidentiality, all entries were recorded anonymously. Personally identifiable information was not collected from participants during the survey. Privacy of the subjects' information was strictly maintained throughout the study duration.

Risks and Benefits:

Participants were informed that no adverse effects associated with participating in the study would compromise their rights or welfare. Additionally, no direct benefits were offered to participants for their involvement in the study.

Ethical Clearance

The study protocol was submitted for review and approval to the Nigeria Health Research Ethics Committee (NHREC). Permission was also obtained from the administrators of the health facilities where data collection was conducted.

RESULTS

1,180 survey entries were received, and 47 (4.0%) responses were excluded from data analysis because they did not meet the inclusion criteria. Of the 1,133 responses included in the analysis, 405 were received from HCWs, and 728 were from persons with chronic illnesses.

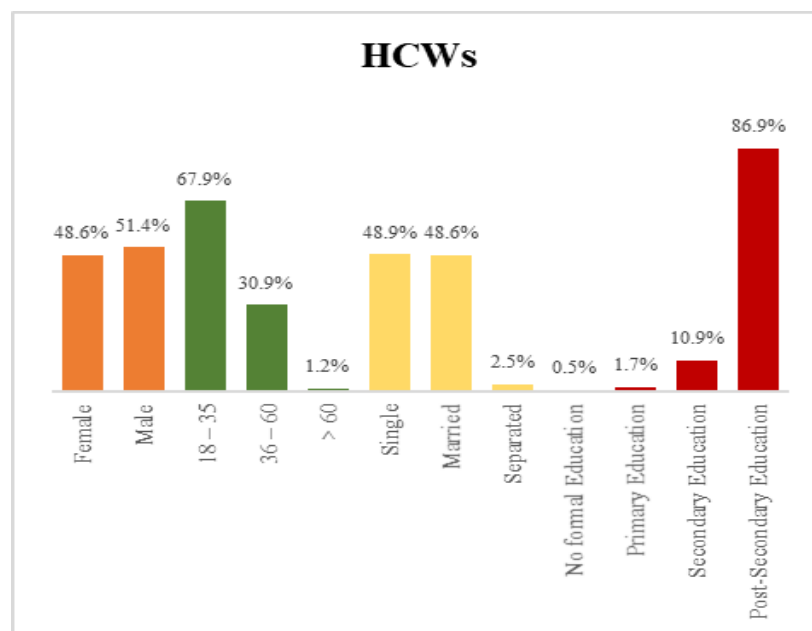
Table 1: Demographics of the participants of HCWs and Patients with chronic diseases

Variables	HCWs, n = 405	Patients, n = 728
Gender		
Female	197 (48.6%)	407 (55.9%)
Male	208 (51.4%)	321 (44.1%)
Age group (years)		

18 – 35	275 (67.9%)	338 (46.4%)
36 – 60	125 (30.9%)	365 (50.1%)
> 60	5 (1.2%)	25 (3.4%)
Marital Status		
Single	198 (48.9%)	187 (25.7%)
Married	197 (48.6%)	419 (57.6%)
Separated	10 (2.5%)	122 (16.8%)
Employment Status, n = 728		
Unemployed	N/A	475 (65.2%)
Employed	N/A	253 (34.8%)
Highest Educational Qualification		
No formal Education	2 (0.5%)	97 (13.3%)
Primary Education	7 (1.7%)	135 (18.5%)
Secondary Education	44 (10.9%)	295 (40.5%)
Post-Secondary Education	352 (86.9%)	201 (27.6%)

N/A = Not applicable

Table 1 and Fig. 1 show the demographic characteristics of the participants of HCWs and patients with chronic diseases. Most patient participants were female, accounting for more than half of the total patient participants, 407 (55.9%), while among HCWs, 208 (51.4%) were male. The most significant proportion of HCW participants fell within the 18-35 age range, comprising 275 (67.9%) of the total HCW participants, while 365 (50.1%) of the patient participants were within the age bracket of 36 – 60 years. More than half of the patients (57.6%) were married, with 40.5% having secondary educational qualifications and unemployed (65.2%). Most HCWs (86.9%) were holders of post-secondary educational qualifications.



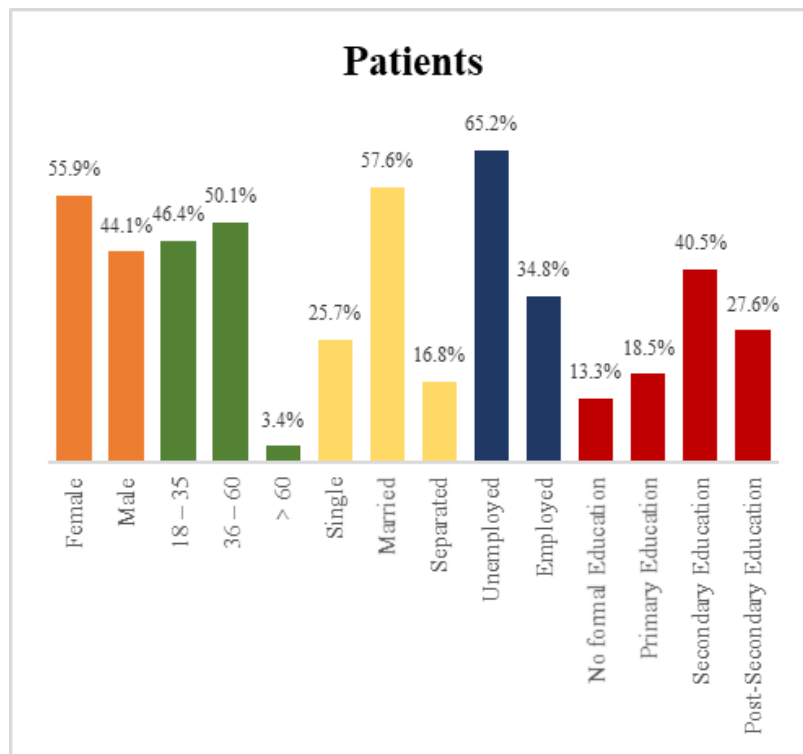


Fig. 1: Demographic characteristics of the participants

HCWs' Perception of the Smart Lockers' Benefits for Chronic Disease Medication

Table 2: HCWs' Perception of the Smart Lockers' Benefits, N = 405

Perceived Benefits	Mean	SD
Improve drug adherence	3.57	1.34
Encourage patients to come to the hospital	3.63	1.25
Make it easier to track patients' health status	3.37	1.32
Low maintenance costs	3.49	1.21
Reduce stigmatization and discrimination of patients living with chronic diseases	3.70	1.38
Reduce the workload of HCWs	4.40	0.86
Reduce the strain on health facility resources	4.31	0.86
Decongestion of health facilities	4.50	0.70
Reduce patient waiting time	4.57	0.74
Overall benefits	3.95	0.50

SD = Standard Deviation

Table 2 presents HCWs' perceptions of the benefits of using Smart Lockers as Virtual Dispensing Units for chronic disease medication. On average, HCWs rated all perceived benefits above the neutral point (3 on the Likert scale), indicating a generally positive perception. The highest-rated benefits were reducing patient waiting time (Mean = 4.57) and decongestion of health facilities (Mean = 4.50), suggesting that HCWs perceive Smart Lockers as effective in addressing these issues. Additionally, reducing the workload of HCWs (Mean = 4.40) and reducing strain on health facility resources (Mean = 4.31) were rated highly, indicating that Smart Lockers are valuable tools in streamlining healthcare processes and resource management. Other perceived benefits received slightly lower but still positive

ratings, such as improving drug adherence (Mean = 3.57) and encouraging patients to come to the hospital (Mean = 3.63). However, HCWs rated the benefit of making it easier to track patients' health status relatively lower (Mean = 3.37). The overall mean perceived benefits, representing the collective opinion of HCWs regarding the effectiveness of Smart Lockers as VDU for chronic disease medication, is 3.95, indicating that HCWs perceive the benefits of using Smart Lockers as advantageous in improving various aspects of healthcare delivery for chronic disease management.

Relationship Between Demographic Characteristics of the HCWs and the Perceived Benefits of Smart Lockers

Table 3: Relationship Between Demographic Characteristics and Benefits

Demographics	Perceived Benefits								
	Improve drug adherence. (M)	Encourage patients to come to the hospital. (M)	Make it easier to track patients' health status (M)	Low maintenance costs (M)	Reduce stigmatization and discrimination of patients living with chronic diseases (M)	Reduce the workload of healthcare workers (M)	Reduce the strain on health facility resources (M)	Decongestion of health facilities (M)	Reduce patient waiting time (M)
Gender									
Female	3.28*	3.54	3.19*	3.37*	3.52*	4.30*	4.23	4.43*	4.53
Male	3.83	3.72	3.53	3.61	3.88	4.48	4.39	4.57	4.62
Age group (years)									
18-35	3.63	3.68	3.41	3.53	3.75*	4.41	4.29	4.45	4.53
36-60	3.47	3.58	3.31	3.41	3.68	4.38	4.34	4.60	4.66
Above 60	1.52	2.40	2.60	3.40	1.80	4.20	4.60	4.80	5.00
Marital Status									
Single	3.69	3.77*	3.50	3.53	3.77	4.42	4.30	4.45	4.59
Married	3.47	3.53	3.26	3.44	3.66	4.38	4.31	4.54	4.54
Separated	3.00	2.90	2.80	3.90	3.10	4.20	4.50	4.70	5.00
Highest Educational Qualification									
No formal Education	3.50	2.00	3.00	4.00	5.00	5.00	5.00	5.00	5.00
Primary Education	3.43	4.14	3.57	3.71	4.00	4.43	4.43	4.71	4.43
Secondary Education	3.77	3.73	3.52	3.64	3.82	4.30	4.02	4.61	4.73
Post-Secondary Education	3.54	3.62	3.35	3.47	3.68	4.40	4.34	4.48	4.55

*p < 0.05

Table 3 presents HCWs' perceptions of Smart Lockers, revealing significant variations in perceived benefits across different demographic factors. In addition to gender, factors such as age and marital status also played substantial roles in shaping these perceptions.

Regarding gender, male HCWs agreed more on certain perceived benefits than their female counterparts. The male HCWs rated the benefit of improving drug adherence significantly higher (Mean = 3.83, $p < 0.05$) than female HCWs (Mean = 3.28). Similarly, male HCWs expressed greater agreement regarding the benefit of making it easier to track patients' health status (Mean = 3.53, $p < 0.05$) compared to female HCWs (Mean = 3.19). Furthermore, age appeared to influence HCWs' perceptions of Smart Lockers' benefits. Younger HCWs (aged 18-35) tended to rate the benefits of reducing stigmatization and discrimination of patients living with chronic diseases more positively, with statistically significant differences observed (Mean = 3.75, $p < 0.05$) compared to participants aged 36 – 60 (Mean = 3.68) and Above 60 years (Mean = 1.80). Moreover, marital status emerged as another influential factor. Single HCWs tended to rate certain benefits, such as encouraging patients to visit hospitals, (Mean = 3.77, $p < 0.05$) more favourably compared to married (Mean = 3.53) or separated participants (Mean = 2.90), with statistically significant differences ($p < 0.05$).

Patients Perception of the Smart Lockers' Benefits for Dispensing Chronic Disease Medication

Table 4: Patients Perception of the Smart Lockers' Benefits, N = 728

Perceived Benefits	Mean	SD
Reduce transportation costs associated with accessing care	3.84	1.31
It minimizes time spent waiting at healthcare facilities	4.26	0.90
Improve adherence to treatment by patients	3.55	1.16
Overall Benefits	3.88	0.36

SD = Standard Deviation

Table 4 outlines patients' perceptions of the benefits of Smart Lockers as VDU for chronic disease medication. The mean scores suggested that patients generally perceive these benefits positively, with higher mean ratings for minimizing time spent waiting at healthcare facilities (Mean = 4.26) compared to reducing transportation costs associated with accessing care (Mean = 3.84) and improving treatment adherence by patients (Mean = 3.55). The overall mean score for patients' perceptions of the benefits associated with Smart Lockers for dispensing chronic disease medication is 3.88. This indicates a generally positive perception among patients regarding the utility of Smart Lockers in addressing healthcare needs. The patients perceive Smart Lockers as potentially beneficial in improving aspects such as reducing hospital waiting times and enhancing treatment adherence.

Relationship Between Demographic Characteristics of the Patients and the Perceived Benefits of the Smart Lockers

Table 5: Relationship Between Demographic Characteristics and Benefits

	Perceived Benefits		
Demographic s	Reduce transportation costs associated with accessing care	It minimizes time spent waiting at healthcare facilities	Improve adherence to treatment by patients
Gender			
Female	3.74*	4.25	3.48
Male	3.97	4.27	3.63
Age group (years)			
18-35	3.75	4.22	3.50

36-60	3.91	4.29	3.61
Above 60	4.04	4.20	3.36
Marital Status			
Single	3.83	4.23	3.53
Married	3.83	4.27	3.52
Separated	3.88	4.25	3.68
Employment Status			
Unemployed	3.82	4.20*	3.61*
Employed	3.87	4.37	3.43
Highest Educational Qualification			
No formal Education	3.75	3.97*	3.32*
Primary Education	3.86	4.36	3.76
Secondary Education	3.81	4.16	3.57
Post-Secondary Education	3.90	4.48	3.49

*p < 0.05

Table 5 illustrates patients' perceptions of Smart Lockers, revealing notable differences linked to various demographic factors. Patients' perceptions of Smart Lockers vary significantly based on gender. Male patients, on average, expressed higher agreement regarding the perceived benefit of improving adherence to treatment by patients (Mean = 3.97, $p < 0.05$) compared to female patients (Mean = 3.74). Regarding employment status, employed patients showed significantly higher agreement (Mean = 4.37, $p < 0.05$) than unemployed patients (Mean = 4.20) concerning the benefit of minimizing time spent waiting at healthcare facilities. Educational qualifications also influenced patients' perceptions. Those with post-secondary education demonstrated significantly higher agreement (Mean = 4.48, $p < 0.05$) regarding the benefit of minimizing time spent waiting at healthcare facilities compared to patients with lower educational levels.

DISCUSSION

This study assessed the perceived benefits of Smart Lockers as VDU from the perspectives of HCWs who manage chronic diseases and patients with chronic diseases. The benefits of Smart Lockers from the patients' perspective include a reduction in the cost of transportation, a reduction in hospital waiting time, and improved adherence to treatment regimens. From the perspectives of HCWs, Smart Lockers helped to reduce stigmatization and discrimination against patients, reduced their workload, reduced the strain on health facilities, decongested health facilities, reduced patients' waiting time, encouraged patients to come to the hospital, and improved drug adherence.

Health systems in low and middle-income countries like Nigeria face a myriad of barriers to providing chronic disease care. These factors are linked to limited resources, a shortage of skilled health workforce, poor economic conditions, and over-reliance on external support and

funding for health programs.^[25-27] Our results showed that most patients receive drug refills from the hospital or clinic where they are registered. This may be linked to chronic disease care not being provided at the primary healthcare level, leading to high demand for chronic disease health services at the secondary and tertiary health facilities.^[28] Also, it may be due to concurrent clinical check-ups and refill appointments, which make patients visit the hospital for their drugs and routine clinical examinations.^[18,29] However, the high patient volume in many secondary and tertiary health institutions that provide care for chronic diseases increases the strain on the already burdened health facility resources because it leads to long waiting times for patients attending these facilities, increases workload and fatigue among the HCWs, and prevents HCWs from interacting with their patients.^[30] A study conducted in Peru reported that the average waiting time was 104.2 minutes and the average consulting time was 12.1 minutes for patients in secondary health facilities which affects patient satisfaction and quality of care significantly negatively.^[31] A similar study conducted in Mozambique recorded average waiting times between 16.2 – 58.8 minutes, 8 minutes for pharmacy delays, and 15.6 minutes for laboratory wait times, while consultation ranged between 2.3 minutes – 9.4 minutes for outpatients, pediatric and antenatal visits.^[32] These factors inadvertently significantly impacted each patient's quality of care. Most HCWs surveyed in this study believe that using Smart Lockers for chronic disease medication will reduce strain on health facility resources and the workload for HCWs. They also agreed that Smart Lockers will reduce patient waiting times and patient volumes in health facilities. This is in tandem with the findings of other studies, which agree that decentralizing care for chronic diseases will improve health services and reduce the workload of HCWs.^[21,33]

Moreover, patients often have to travel long distances to access care, and placing Smart Lockers within the health facility where they usually receive care would likely reduce waiting time, as they can more readily access their drugs without waiting in long pharmacy/dispensary queues.^[28,34] Kiunguyu (2018) ^[35] reported such a model of implementation for Smart Lockers in ART clinics in South Africa. Although this provided medication access within three minutes and benefited patients without losing time from work on their appointment days, it does not eliminate the challenge of transportation costs for patients since they may still have to travel far to reach the health facility.^[35] This is similar to the findings of another study in Vietnam, where the cost of transportation to the location of Smart Lockers for medication pick-ups impaired the satisfaction of patients.^[36]

Several studies have reported that patients missed their clinical appointments due to the cost of transportation to the health facility and long distances to the health facilities where they receive care.^[37-39] While the results of this study suggest that the use of Smart Lockers has the potential to alleviate some of these concerns and contribute to an increase in the likelihood of treatment adherence, it is worth noting that the question of treatment adherence is multifaceted. Treatment adherence for chronically ill persons has been linked to service delivery, personal preferences, and economic and cultural factors.^[40,41] Nonetheless, studies have documented the benefits of decentralizing care and empowering individuals and their communities by increasing community engagement in providing quality health services for chronic diseases, thus enhancing patient safety and continuity in care.^[42]

It is one thing to provide decentralized and person-centred care, and it is another thing for patients to accept this model of care. For example, Mukora et al. ^[43] reported that patients living

with HIV (PLHIV) are hesitant to accept out-of-facility care. These patient-level concerns are linked to stigmatization and discrimination issues.^[44–46] In this study, HCWs believed that VDU would reduce stigmatization and discrimination among persons with chronic diseases. This agrees with the results of a systematic review that examined the impact of various interventions to reduce the stigmatization of patients with tuberculosis in the Americas, Africa, and Asia. Their results show that when patients' care is brought closer to the community, it improves the general orientation and awareness of that disease.^[47] The community-based care and community mobilization to reduce the stigma around PLHIV increases community awareness and orientation, which, in turn, improves people's attitudes toward people living with such diseases.

A review by Lall et al.^[27] revealed that a gap persists in linking patients to quality care accessible within their community in low-and-middle-income countries like Nigeria.^[27] There has been an increased focus on decentralizing care in line with the United Nations UHC targets, and this calls for improved access to care by strengthening decentralized, person-centred health systems. The potential of Smart Lockers to reduce transportation costs also depends on the location of the lockers. Placing the lockers at convenient locations such as health clinics, community pharmacies, or other locations within the community that are closer to the patients will be more beneficial to the patients.

LIMITATIONS

Our study focused on the benefits of Smart Lockers as VDU that border on timely access to care and reduce logistics issues during clinical visits by patients. However, the study does not include the cost of procuring, installation, maintenance, and adaptability of Smart Lockers.

Although a similar study was conducted by Thapa et al.^[48] to examine stigma reduction about Antiretroviral drugs (ARVs) uptake in low- and middle-income countries using Smart Lockers demonstrated that Smart Lockers are efficient in stigma reduction and cost-effective.

Furthermore, the cross-sectional design of our study limited the ability to establish causality or track changes in perceptions over time. Additionally, the generalizability of our findings may be limited, as data collected from specific secondary healthcare facilities in selected states may not fully represent all healthcare settings in Nigeria or other regions. Despite these limitations, our study provides valuable insights into the potential utility and associated benefits of Smart Lockers in healthcare settings, highlighting areas for further research and consideration.

CONCLUSION

This study sheds light on the perceptions of HCWs and patients regarding the benefits of Smart Lockers as VDU for chronic disease medication in Nigeria. The findings underscore the significant positive impact of Smart Lockers on healthcare delivery, particularly in reducing HCWs' workload, decongesting healthcare facilities, and decreasing patient waiting time. Patients also perceive benefits such as minimizing time spent waiting at healthcare facilities and positively reducing transportation costs associated with accessing care. Moreover, demographic factors such as gender, employment status, and educational qualification are crucial in shaping perceptions of Smart Locker benefits. Male HCWs and patients and employed patients exhibit more favourable perceptions compared to their female counterparts and unemployed patients, respectively. Additionally, patients with higher educational qualifications

express more positive views of Smart Lockers benefits than those with lower educational levels. These insights highlight the potential of Smart Lockers to enhance healthcare delivery and patient outcomes in Nigeria. Healthcare providers and policymakers can effectively integrate Smart Locker technology into chronic disease management strategies by addressing disparities in perceptions and leveraging the identified benefits. Tailored interventions targeting specific demographic groups can further optimize the acceptance and utilization of Smart Lockers, ultimately contributing to improved healthcare access and quality of care for persons living with chronic illnesses in Nigeria.

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Appendix: Distribution of States and Facilities

State	Facility
Adamawa	Michika General Hospital
	Mubi General Hospital
	Numan General Hospital
	Song Cottage Hospital
Akwa Ibom	Ikpe Ikot Nkon General Hospital
	Etim Ekpo General Hospital
	Ibiono Handmaids Hospital
	Ikono General Hospital
	Ikot Ekpene General Hospital
	Ikot Ekpene Primary Health Centre
	West Itam Primary Health Center
	Mbiabong Itam Health Center
	Nto Edino Comprehensive Health Centre
	Ukana Cottage Hospital
	Ukpom Abak General Hospital
	Urua Inyang Primary Health Centre
Benue	Aliade General Hospital
	St. Gregory Health Center
	St. Vincents Hospital
	Adikpo General Hospital
	Nongu u Kristu ke Sudan hen Tiv (NKST) Hospital - Jato Aka
	St. Monica's Hospital - Adikpo
	St. Mary's Hospital - Okpoga
	Oturkpo General Hospital
	Nongu u Kristu ke Sudan hen Tiv (NKST) Hospital - Mbaakon
	Sev-Av Foundation - Vandeikya
	St. Thomas Hospital - Ihugh
	Vandeikya General Hospital
Cross River	Obanliku General Hospital
	Ogoja Catholic Maternity Hospital
	Ogoja General Hospital

	Sacred Heart Catholic Hospital
Niger	General Hospital -Bida
	Federal Medical Centre - Bida
	General Hospital Mokwa
	General Hospital Lapai
	General Hospital New Bussa
	General Hospital Kontagora