West African Journal of Pharmacy (2022) 33 (2) 116 - 128

Pharmaceutical waste management in community pharmacies in Lagos State, Nigeria

Ukamaka G. Okafor, Modupe R. Oyawole, Isimeme B. Sawyer, Nkem M. Obiakor,
Temitope O. Akinboro, Titilayo, A Onedo

Association of Hospital and Administrative Pharmacists (AHAPN)
Lagos State Branch, Nigeria

Corresponding author: Ukamaka G. Okafor
Email: chinaemelum9291@yahoo.com Telephone : +234 8033253463

ABSTRACT

Background: An average community pharmacy in Lagos State, Nigeria, stocks between 2000 to 4000 drug items. A significant amount of waste has been found in both underground and drinking water from these drug items. Poor management of pharmaceutical wastes exposes the community to toxic environmental effects.

Objective: This study assessed the management of pharmaceutical wastes by community pharmacies in Lagos State.

Methods: The cross-sectional study among community pharmacists recruited participants through social media platforms or in person at the Pharmacists Council of Nigeria (PCN) office during their visit.

Results: A total of 211 respondents completed the survey. Of this, 74.4% were aware of proper pharmaceutical waste management. Storage of pharmaceutical wastes were found to be both in the pharmacy and other specified places. About 41.7% were aware of the periodic requests for waste submission by the Association of Community Pharmacists of Nigeria while 48.3% were unaware. 71.6% of them generated wastes outside pharmaceutical wastes (chemicals, sharps, infectious) while 23.7% did not. Respondents generated wastes monthly (32.7%), non-regular (23.7%), quarterly (17.5%) and yearly (14.7%). About 43.1% disposed their wastes themselves and 21.3% disposed via regulatory agencies.

Conclusion: The level of awareness of appropriate pharmaceutical waste management is high but practice of standard disposal methods is low. Measures are needed to improve pharmaceutical waste management in Lagos State.

Keywords: Community Pharmacists, Pharmaceutical waste, management, disposal

Gestion des déchets pharmaceutiques dans les pharmacies communautaires de l'État de Lagos, Nigeria

Ukamaka G.Okafor, Modupe R. Oyawole, Isimeme B. Sawyer, Nkem M. Obiakor,
Temitope O. Akinboro , Titilayo, A Onedo .

Association des pharmaciens hospitaliers et administratifs (AHAPN)
Agence de l'État de Lagos, Nigéria

Auteur correspondant: Ukamaka G. Okafor
Email: chinaemelum9291@yahoo.com Téléphone : +234 8033253463

RÉSUMÉ

Contexte : Une pharmacie communautaire moyenne de l'État de Lagos, au Nigéria, stocke entre 2 000 et 4 000 articles médicaments. Une quantité importante de déchets a été trouvée dans le sous-sol et dans l'eau potable à partir de ces articles de drogue. La mauvaise gestion des déchets pharmaceutiques expose la communauté à des effets environnementaux toxiques.

Objectif : Cette étude a évalué la gestion des déchets pharmaceutiques par les pharmacies communautaires dans l'État de Lagos.

Méthodes : L'étude transversale auprès des pharmaciens communautaires a recruté des participants par le biais de plateformes de médias sociaux ou en personne au bureau du Conseil des pharmaciens du Nigéria (PCN) lors de leur visite.

Résultats : Au total, 211 individus ont répondu au sondage. Parmi eux, 74,4 % étaient conscients de la gestion appropriée des déchets pharmaceutiques. Le stockage des déchets pharmaceutiques se fait à la fois dans la pharmacie et dans d'autres endroits spécifiques. Environ 41,7 % étaient au courant des demandes périodiques de soumission de déchets par l'Association des pharmaciens communautaires du Nigéria, tandis que 48,3 % ne le savait pas. 71,6% d'entre eux généraient des déchets autres que pharmaceutiques (produits chimiques, objets tranchants, déchets infectieux) contre 23,7 % qui ne le faisaient pas. Les répondants généraient des déchets mensuellement (32,7 %), irrégulièrement (23,7 %), trimestriellement (17,5 %) et annuellement (14,7 %). Environ 43,1 % éliminaient leurs déchets eux-mêmes et 21,3 % les éliminaient par l'intermédiaire d'organismes de réglementation.

Conclusion : Le niveau de sensibilisation à la gestion appropriée des déchets pharmaceutiques est élevé, mais la pratique des méthodes d'élimination standard est faible. Des mesures sont nécessaires pour améliorer la gestion des déchets pharmaceutiques dans l'État de Lagos.

Mots clés : Pharmaciens communautaires, déchets pharmaceutiques, gestion, élimination

INTRODUCTION

Pharmaceutical waste is defined as waste from any chemical or biological product or medicine that is intended for use in the diagnosis, cure, mitigation, care, treatment, or prevention of disease or injury of humans or other animals. It includes expired, damaged, unused, or no longer needed medications, veterinary medicines, nutritional supplements, herbal medicines, various alcoholic and non-alcoholic beverages and drugs of abuse that are used for non-medical purposes, over-the-counter personal care products, and sometimes accessories such as sharps, used test strips, masks, bottles, and other supplies, including wastes from vaccines and biological products used for therapy.[1,2,3,4] Pharmaceutical waste also includes all the drugs and equipment used for the mixing and administration of cytotoxic drugs. Cytotoxic drugs or genotoxic drugs are drugs that can reduce/stop the growth of certain living cells and are used in chemotherapy for cancer.[5]

Large quantities of these wastes kept at pharmacies, distribution centers, hospitals, etc. must be managed to minimize the risk of release or exposure to workers and the public.[4,6] In the past, health care facilities would routinely flush waste pharmaceuticals down the drain and society didn't know how detrimental these drugs would be to the environment. However, the incumbent environmental toxicity due to pharmaceutical waste disposal calls for more attention to this aspect of health regulation.[4,7]

A cross-sectional descriptive survey carried out by Oladimeji-Salami on healthcare workers involved in the use and disposal of pharmaceutical waste in several hospitals and pharmacies in Lagos state, Nigeria using structured questionnaires, found limited knowledge and poor practice of pharmaceutical waste disposal among the respondents. Most of the respondents indicated that there was no waste disposal method in place for pharmaceutical wastes.[6]

Another questionnaire survey to ascertain, waste management practices, knowledge of waste management policies, and subjection to regulatory control was conducted in fifty (50) selected Nigerian-based pharmaceutical businesses that mainly act as local manufacturers and major importers of medicines. This survey indicated that like its counterpart industry in other countries of the world, the Nigerian pharmaceutical industry generated both hazardous and non-hazardous wastes.[8] However, the wastes were not categorized, were poorly managed by the majority of the respondents, and about half of the health and safety personnel had little or no modern knowledge of waste management. Furthermore, the majority of the respondents claimed that they were aware of the regulatory requirements on waste, but no adherence was observed.[8]

Classification of pharmaceutical wastes

They can be classified into the following groups:-

- Hazardous wastes e.g. carcinogenic or mutagenic agents.
- Non-hazardous wastes e.g. non-carcinogenic.
- Non-pharmaceutically active waste e.g. dietary supplements, intravenous fluids.
- Flammable, irritant, harmful, oxidizing or eco-toxic medicines e.g. disinfectants.[9]

Disposal of pharmaceutical wastes

Disposal methods that have been utilized for unwanted pharmaceuticals are:

- Return to donor or manufacturer
- Disposal through landfill
- Waste immobilization
- Through server system
- Burning in open containers
- Medium temperature incineration
- Novel high-temperature incineration
- Chemical decomposition

Poor management of healthcare waste exposes health workers, waste handlers, and the community to the toxic effects of waste generated from health activity. The disposal of these wastes could also lead to environmental problems.[10]

To ensure the effective management of health care waste, the following has to be put into consideration: types/classification, safe storage, and transportation of waste. Lack of proper and complete knowledge about biomedical waste management impacts practices of appropriate waste disposal.[11]

Management strategies based on the type of waste involved:

Hazardous waste - required to use of a hazardous waste incinerator.

Return to pharmacy stock - applicable when the facility/and or payer contracts mandate credits for

unused medications, as long as medications meet return guidelines.

Reverse distribution - typically appropriate for pharmacies or in the case of creditable expired drugs still contained within original manufacturer packaging.[11]

Non Hazardous pharmaceuticals -may be incinerated at a medical waste treatment facility or waste-to-energy processing plant while trace chemotherapy drugs - to be incinerated at a medical waste treatment facility.[12]

It is dangerous to allow unqualified persons to handle pharmaceutical wastes. Pharmaceutical waste management is especially challenging, given the complexity of the regulations and the multiplicity of regulatory agencies that govern its activities. In the United States, pharmaceutical waste management is regulated by agencies such as:-

- Environmental Protection Agency (EPA)
- Department of Transportation (DOT)
- Drug Enforcement Administration (DEA)
- Occupational Safety and Health Administration (OSHA)
- Pharmacy Board

Treatment, storage and disposal of hazardous waste in the United States are regulated under the "Resource Conservation and Recovery Act" (RCRA) in 40 CFR 261 which is divided into 2 major categories:

1. Characteristic Waste:- According to the characteristics exhibited by the chemicals, like ignitability, reactivity, corrosiveness, and toxicity.

2. Listed Hazardous Wastes are materials specifically listed by regulatory authorities as hazardous wastes which are from non-specific sources, specific sources, or discarded chemical products.[13]

In Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) regulates the disposal of medicines and other regulated products considered unwholesome, including expired, improperly sealed, damaged, and improperly stored medicines.[14] Individual states also employ additional regulations regarding chemotherapy waste, infectious waste, and sharps container disposal.[15] In Lagos State, the Lagos State Environmental Protection Agency (LASEPA) is responsible for waste disposal including pharmaceutical waste, which has its own procedures for disposal after segregation.

There are limited studies on pharmaceutical waste management practices among community pharmacies in Lagos state. Hence, the need for this survey.

METHODS

Study design

The study was cross-sectional and was conducted in Lagos state, located in the southwestern part of Nigeria. Lagos state is the most economically important and most populous state in Nigeria. It is the smallest state, with an area of 356,861 hectares of which 75,755 hectares are wetlands. According to the 2006 National Census, the state has about three million households with a population of 9,013,534 and a projected population of 24.6 million in 2015.[16]

Sample size determination

The population of concern was the practicing community pharmacists in Lagos State, Nigeria. The total number of this population as of December, 2020 was 2,825. Single proportion formula was used in the determination of the minimum sample size, with a margin of error of 7% and a confidence interval of 95%. The minimum sample size was calculated by an automatic sample size calculator to be 184.[17]

Development and validation of the questionnaire

The questionnaire was developed from a review of literature and discussions with subject matter experts.[18,19] The questionnaire was validated among 10 experts who are pharmacists with a postgraduate degree and research experience. They were asked to give feedback in terms of relevance of the items to the study objectives, wording, any terms that may look ambiguous to the study participants and if respondents would comprehend the content of each question and be able to answer them appropriately. Thereafter, it was revised based on the feedback received from these experts.

The validated questionnaire was pretested among 15 Community Pharmacists in Ikosi/Ketu Zone between September 14, 2020 and October 5 2020. The participants were requested to respond to the questionnaire and to identify any item/term that they misunderstood, found ambiguous, or if they encountered any other difficulties in completing the questionnaire. The results of the pretest were not provided in this study but the findings were used to

review the questionnaire and develop the final version. The final version was designed into Google Form. The 27-item questionnaire contained both open ended and close ended questions and sought information on participants' demography (3), premises (4), knowledge on pharmaceutical waste disposal (6), types and generation of wastes (4), methods of waste disposal (7), cost of pharmaceutical waste generated (2) and challenges of pharmaceutical waste disposal (multiple options).

Data collection and analysis

The validated questionnaire was administered to community pharmacists in Lagos state in a cross-sectional descriptive survey. Two approaches were used in the recruitment of participants in order to ensure increased participation; a face-to-face and online survey. The physical data were obtained when the respondents visited the Pharmacists Council of Nigeria, Lagos Zonal Office using manual survey tools and in Community Pharmacists Association meetings. The hyperlink of the Google Form was shared with target participants through WhatsApp groups and individual accounts using broadcast feature. The hyperlink was also sent to the coordinators of the respective ACPN zones for subsequent sharing to their zonal members. For those respondents who manually filled some questionnaires, their responses were converted into electronic forms with the use of the Google form version of the survey. The data collection exercise began on November 5, 2020 and ended on March 3, 2021.

A summary of all responses was exported via Google sheet, thereby bypassing data entry stage.

The acquired data were analyzed using the Statistical Package for Social Sciences (SPSS) version 23. The quantitative part of the questionnaires (demographic details and close-ended questions) was analyzed with the use of descriptive statistics which gave the frequency of response to each question, and these frequencies were presented as tables and charts. The obtained qualitative data, where the respondents were allowed to comment freely, was manually categorized and used to draw inductive conclusions and recommendations.

Ethical approval

Ethical approval for this research was sought and obtained from the Health Research and Ethics Committee of Lagos State University, Lagos State.

RESULTS

A total of 211 community pharmacists responded to the survey. From this number, 43.6% were in the age range of 25-34 years. An estimated 23.7% were in the age range of 35-44 years, 19.4% were in the range of 45-54 years, 9.5% were between 55 and 60 years and 2.8% of the respondents were above 60 years. Males were 57.3% and 42.7% were female. From the total respondents, 52.1% had less than 10 years post qualification, 25.6% had 11 to 20 years of post-qualification, 10.4% were in the category of 21-30 years of post-qualification, and 11.8% had over 30 years of post-qualification. Most of the respondents were not the owners of the community pharmacies where they worked (53.6%).

The study respondents were from 17 Local Government Areas in Lagos State with the maximum number of respondents working in Alimosho (17.5%), followed by Kosofe (8.5%), and then Surulere (5.7%).

The following tables give a summary of the responses to majority of the survey questions as provided by the respondents.

Table 1: Evaluation of community pharmacists' knowledge of pharmaceutical waste disposal

Survey question	Response	Percent
Are you aware of pharmaceutical waste management?	Yes	74.4
	No	13.7
	Maybe	5.2
If yes, how did you come about the knowledge?	During industrial training	0.5
	Just hearing about this	2.0
	Post-graduate study	13.3
	Post-graduate study Seminars/training/MCPD	2.8
	Seminars/training/MCPD	22.3
	Through the government hospital	0.5
	Undergraduate study	34.6
	Undergraduate study, Post graduate study	3.3
	Undergraduate study, Seminars/training/MCPD	4.7
Are you aware of periodical ACPN request for pharmaceutical waste submission/collection for appropriate disposal by responsible organization?	**Yes**	**41.7**
	No	48.3
	Maybe	1.9

Table 2: Evaluation of community pharmacists' perception of pharmaceutical waste disposal

Survey question	Response	Percent
Should pharmacists be involved in pharmaceutical waste management?	Yes	89.6
	No	0.5
	Maybe	3.8
Who should be responsible for pharmaceutical waste management?	Manufacturers	3.0
	Pharmacist	30.6
	Regulatory bodies	32.6
	State government	26..0
	Federal government	7.8
Which of these bodies should be responsible for pharmaceutical waste management?	ACPN	15.2
	LASEPA	17.5
	NAFDAC	37.4
	NDLEA	5.7
	PCN	8.1
	PSN	4.3
	SON	1.9

Table 3: Evaluation of community pharmacists' practices of pharmaceutical waste disposal

Survey question	Response		Percent
How do you generate pharmaceutical waste?	Diagnostic consumables		0.4
	Clients return		13.1
	Damaged stock		29.2
	Expired stock		33.0
	Disposables from pharmacy		0.2
	Manufacturing errors		0.2
	Sharps from rapid diagnostic tests		0.4
	All of the above	23.4	
What kind of pharmaceutical waste is being generated in your premises?	Controlled drugs		15.0
	None		0.2
	Solids		29.0
	Liquid		0.5
	Semi solid		20.2
	Infusions		15.0
	Injectables		19.6
	Syrups, Suspension powders		0.2
Do you generate other wastes apart from pharmaceuticals?	All of the above	0.3	
	Yes	71.6	
	No	22.7	
If yes, please specify.	Chemicals		12.0
	General		44.7
	Infections		9.8
	Sharps		33.5

In what categories are the wastes segregated?	Liquids		33.2
	Solids		39.5
	Foams, paper, plastic		0.3
	Infectious and non-infectious		0.7
	No segregation		24.7
	Sharps		0.3
	Sharps box for sharp		0.3
	Syringes, needles		0.3
	Paper and sand		0.3
	Sharps and others		0.3
Where do you store pharmaceutical wastes prior to disposal?	Designated areas outside the premises		.5
	In the pharmacy		65.4
	In the house		1.9
	Outside the pharmacy		6.6
	Inside the store		1
	Special store for regulated items		.5
Do you have a designated area in the pharmacy for storing pharmaceutical waste prior to disposal?	Yes	81.0	
	No	10.9	
	Maybe	0.9	
How frequently do you dispose pharmaceutical waste?	Daily		1.4
	Daily/weekly		.5
	Depends on NAFDAC's readiness.		.5
	Every 2 days		.9
	Monthly		32.7
	Not regularly		23.7
	not sure		.5
	Once or twice in a year		.5
	Quaterly		17.5
	Through NAFDAC		.5
	Weekly		1.4
	When necessary		.5
	Whenever it's full		.5
	Yearly		14.7

How do you usually dispose pharmaceutical waste?	Local Government	0.4
	Not at all	0.4
	not sure	0.4
	Personally	44.4
	Professional association	18.0
	Regulatory agencies	36.1
	PSN	0.4
If personal, which methods?	Agency	0.4
	Burning	17.3
	Returned to manufacturers	14.1
	General municipal waste	30.5
	Open or flowing gutters	2.4
	Private waste collectors	23.7
	Septic tank/soak aways	6.8
	I don’t	0.4
	Lagos State waste management (biowaste division)	0.4
	NAFDAC	0.4
	No response	2.0
	With the hospital around me	0.4
	Returned to suppliers	0.4
	Sharps through local government phc	0.4
	We don't dispose personally	0.4
If not personally, please indicate your channel of disposal	Through ACPN	21.8
	Through NAFDAC	19.9
	None 58.3	
Estimated cost of pharmaceutical waste management (in naira)	51,000-100,000	15.6
	Less than 50,000	49.8
	More than 100,000	19.9
	No costs	2.4
Challenges of pharmaceutical waste management.	Cost of disposal	17.6
	Irregular collection by responsible bodies	19.8
	Cumbersome disposal method	19.1
	Logistics to get the waste to the disposal centre	23.3
	Storage space	20.2

DISCUSSION

From the results of the study, the respondents' awareness of the disposal methods of pharmaceutical waste was high (Table 1). However, less than 50% of participants had the knowledge of NAFDAC being an appointed agency that deals with proper pharmaceutical waste management as one of its responsibilities. An absence of awareness of the most recommended means of waste management has a role to play in the waste management practice of an individual.[20]

Now, for pharmaceutical wastes, failure to engage proper waste disposal not only is a burden to the environment in terms of aesthetics, but poses a threat to diverse possibilities, such as recycling of damaged or expired drugs by a random individual who comes across the wastes in an accessible area, environmental hazards due to products of burning or escape of some drug components into water bodies, etc.[21] Michael et al. reported a knowledge gap in this sector as lack of awareness was highlighted as a pivotal issue and recommended that lectures on proper waste management be rendered to pharmacists to promote its practice.[22]

Following the NAFDAC guidelines, not only should waste be properly disposed of but the documentation should also be done towards that. Segregation of wastes generated is also a recommendation.[14] From the responses, the majority of the pharmacists identified their wastes as being segregated into different forms. The majority of the community pharmacists in Saudi Arabia returned unused medications back to the drug industries (over 73%).[23] The results from this study, however, shows that most community pharmacists disposed of their wastes personally when compared to other means of disposal. The majority (63%) of community pharmacists in the survey carried out in Kenya also employed private services in handling their generated wastes.[19]

Contrary to the guidelines, a good number of Pharmacists do not seem to have a properly defined separate place where these wastes are kept as the majority affirmed to store them in their pharmacies (65.4%). In a similar research carried out by Alghadeer and Al-Arifi in Saudi Arabia, 85% of the community pharmacists preferred storing these wastes in the pharmacy premises.[23]

Though a good number of the community pharmacists reported regular pharmaceutical waste disposal monthly (32.7%), quarterly (17.5%), the majority of them(44.4%) personally dispose of the wastes, while only (18%) and (36.1%) dispose through professional associations and regulatory agencies, respectively. A similar study in Anambra, Nigeria, revealed high recognition of NAFDAC by community pharmacists as the body in charge of pharmaceutical waste disposal. However, the majority of these pharmacists do not comply with the given guidelines (54.5%).[22]

Just as the NAFDAC has its published guidelines on the processes involved in handling pharmaceutical wastes, Mburu reported a similar publication in Kenya with appropriate description of each procedure.[19]

Although the recommended method of disposal has been highlighted in the publication by NAFDAC in 2018,[14] our results still show that a significant number of pharmacists do not engage in this method. What then could be the problem?

Our study identified 4 major reasons why pharmacists get discouraged to go through the right path of waste management. These are: cost of disposal, irregular collection by responsible agencies, cumbersome disposal method, logistics to get the waste to the disposal site, and storage space.

Cost of disposal is an important factor that has been reported to limit the efforts to properly dispose of these wastes. This issue in pharmaceutical waste disposal was also highlighted in a study in Asian countries carried out by Kadam *et al.*[21] Clavelle also mentions the cost of disposal of this class of waste as an impediment to its practice, suggesting a reduction by agencies in charge in order to encourage propoer waste management.[24] The Community Pharmacists in this study have expressed willingness to comply with proper pharmaceutical waste management methods if the bottlenecks of disposal procedures are alleviated.

Of all these factors, logistics surrounding proper waste disposal was most identified as a problem. This was also buttressed by the additional free comments from the respondents that suggest more convenient methods of carrying out this exercise. He, Li, and Fang conducted a study on how the issues of logistics in pharmaceutical waste disposal can be mitigated and identified.[25] Following the notion of a poorly structured network for obtaining these wastes by the concerned agencies, they recommended a reconstruction of the logistics network regarding receiving and disposing off of these wastes and this can be extrapolated to this study as a recommendation for NAFDAC operations.[25]

CONCLUSION

The study shows a high level of respondents' awareness of pharmaceutical waste management among community pharmacists in Lagos State, Nigeria but compliance with the standard practice of waste management is low. Asides from the lack of willingness to comply, which may be possible, a number of reasonable impeding factors have been identified as sources of discouragement to the pharmacists concerning proper pharmaceutical waste management. Logistics of disposal was observed to be the major reason leading community pharmacists to adopt unconventional ways of pharmaceutical waste disposal.

Although this study helped to obtain information on pharmacists' awareness and practice of pharmaceutical waste management, one limitation of the study is that correlational studies were not considered in order to find the demographic factors that may be related to the waste management practices of the pharmacists. Hence, a recommendation for further research will be to find out if being the owner of a premises has a significant effect on the waste management practice of the pharmacist, the level of awareness of the proper waste management process step-by-step, and finding out if there exists a relationship between the level of a community pharmacist's involvement in ACPN and the practice of waste disposal. This study can also be replicated in other states of the federation.

ACKNOWLEDGMENT

The authors are grateful to the executive committee of the Association of Hospital and Administrative Pharmacists of Nigeria, Lagos State Branch.

REFERENCES

1. WHO, 2018: Health care wastes-key facts Available at: https://www.who.int/news-room/fact-sheets/detail/health-care-waste
2. WHO. (World Health Organization) (2014). Safe Management of Waste from Healthcare activities. 2nd ed.
3. Woolridge and Hobey, 2019: Pharmaceutical Household Waste Practices: Preliminary Findings from a Case Study in Poland. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6598946/ doi: 10.1007/s00267-019-01174-7. Accessed October 5, 2020.
4. Crean D. (n.d.). Malsparo-Medical Waste Collection, Treatment, and Disposal. Available at: https://www.malsparo.com/. Accessed October 5, 2020.
5. Nwachukwu NC, Orji FA , Ugbogu OC. (2013). Health Care Waste Management - Public Health Benefits, and the Need for Effective Environmental Regulatory Surveillance in Federal Republic of Nigeria, Current Topics in Public Health, Alfonso J. Rodriguez-Morales, IntechOpen, DOI: 10.5772/53196. Available at: https://www.intechopen.com/books/current-topics-in-public-health/health-care-waste-management-public-health-benefits-and-the-need-for-effective-environmental-regulat
6. Oladimeji-Salami JA, Lawal FT, Ajasa O, Afolayan GO, Akindele AJ, Olayemi SO, Adeyemi OO. (2017). Evaluation of knowledge and practice of pharmaceutical waste disposal in hospitals and pharmacies within Lagos State, Nigeria. *Nigerian Quarterly Journal of Hospital Medicine* 27 (2): 1-10. Available at: https://www.ajol.info/index.php/nqjhm/article/view/176319
7. Rajbongshi S, Shah YD, and Sajib AU. (2016). Pharmaceutical Waste Management- A Review. *European Journal of Biomedical and Pharmaceutical Sciences* 3 (12): 192-206
8. Ngwuluka NC, Ochekpe NA, Odumosu PO. (2011). An assessment of pharmaceutical waste management in some Nigerian pharmaceutical industries. *African Journal of Biotechnology* 10(54): 11259-11264. Available at: http://www.academicjournals.org/AJB DOI: 10.5897/AJB10.1194 ISSN 1684-5315. Accessed October 4, 2020.
9. Obono M. (2016) Evaluation of Pharmaceutical Waste Disposal Practices in Healthcare Facilities in Lagos State, South West Nigeria. *Texila International Journal of Public Health* 4 (4): 749-757
10. Vanesh M, Dwivedi S, Hassan MA, and Misra RP. (2011). Knowledge, Attitude, and Practices about Biomedical Waste Management among Healthcare Personnel: A Cross-sectional Study
11. Retail Waste Workgroup Webcast, 2016
12. Megan C. (2018). Pharmacies: What to do with your Pharmaceutical Waste. *Indian Journal Community Med*. 36(2): 143-145. doi: 10.4103/0970-0218.84135. Available at: https://www.danielshealth.com/knowledge-center/pharmacies-what-do-your-pharmaceutical-waste
13. Chaudhary R, Rachana M. (2006). Factors affecting hazardous waste solidification/stabilization. *Journal of Hazardous Materials* 137: 267-276

14. NAFDAC (2018). Guidelines for handling and disposal of unwholesome medicines and NAFDAC regulated products (food, medicines, medical devices, cosmetics etc.) in Nigeria. Available at: https://www.nafdac.gov.ng/wp-content/uploads/Files/Resources/Guidelines/INVESTIGATION_ENFORCEMENT_GUIDELINES/Guidelines-for-Handling-and-Disposal-of-Unwholesome-Medicines-and-Other-NAFDAC-Regulated-Products.pdf
15. Letcher TM, Vallero DA. (2011). Waste: A Handbook for Management. DOI: 10.1016/B978-0-12-381475-3.10034-8. 1st Ed. Elsevier Academic Press Editor: S
16. Lagos State Bureau of Statistics (2005). Available at: http://www.lagosstate.gov.ng.
17. Qualtrics.xm (2022). Sample size calculator & complete guide. [Online] Available at: https://www.qualtrics.com/blog/calculating-sample-size/
18. Manojlovic J, Jovanovic V, Miloševic A, Tesink J, Arsic T, and Marinkovic, V. (2015). Pharmaceutical Waste Management in Pharmacies at the Primary Level of Health Care in Serbia - Situation Analysis. *Indian Journal of Pharmaceutical Education and Research*. 49: 106-111. 10.5530/ijper.49.2.5.
19. Mburu, JN. (2012). Handling of Pharmaceutical Waste in Community Pharmacies in Nairobi, Kenya. University of Nairobi Research Archive. Accessed August 28, 2022
20. Bashaar M, Thawani V, Hassali MA, Saleem F. (2017). Disposal practices of unused and expired pharmaceuticals among general public in Kabul. *BMC Public Health* 17(45). Available at: https://doi.org/10.1186/s12889-016-3975-z Accessed August 28, 2022
21. Kadam A, Patil S, Patil S , Tumkur A. (2016). Pharmaceutical Waste Management, an Overview. *Indian Journal of Pharmacy Practice* 9(1): 2-8
22. Michael I., Ogbonna B., Sunday N. Anetoh M and Mathew O. (2019). Assessment of disposal practices of expired and unused medications among community pharmacies in Anambra State southeast Nigeria: a mixed study design. *Journal of Pharmacy Policy and Practice* 12(12). Available at: https://doi.org/10.1186/s40545-019-0174-1 Accessed August 28, 2022
23. Alghadeer S, Al-Arifi MN. (2021). Community Pharmacists' Practice, Awareness, and Beliefs about Drug Disposal in Saudi Arabia. Healthcare (Basel) 9(7):823. doi: 10.3390/healthcare9070823
24. Clavelle A (2020). Challenges with Pharmaceutical Waste Management in the Healthcare Industry. Triumvirate Environmental Available at: https://www.triumvirate.com/blog/challenges-with-pharmaceutical-waste-management-in-the-healthcare-industry
25. He, Z, Li, Q, and Fang, J. (2020). The solutions and recommendations for logistics problems in the collection of medical waste in China. *Procedia Environmental Sciences* 31 (2016): 447 - 456