International Journal of Community Medicine and Public Health
David R et al. Int J Community Med Public Health. 2024 Jul;11(7):2787-2793
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20241839

Original Research Article

A study on household medicine wastage and disposal practices with screening of water samples for antibiotic presence in a South Indian district

Rosme David, Mamatha Jayachandran, Princy Louis Palatty*

Department of Pharmacology, Amrita Institute of Medical Sciences, Kochi, Kerala, India

Received: 08 May 2024
Accepted: 12 June 2024

***Correspondence:**
Dr. Princy Louis Palatty,
E-mail: princylp@aims.amrita.edu

ABSTRACT

Background: Pharmaceuticals in the environment is known since last two decades. As hospitals and pharma industries, household medicines also need proper disposal otherwise they will gradually find their way into environment. So, we did a survey of residents in major metro city to understand their medicine wastage as well as disposal practices.
Methods: Pharmaceuticals in the environment is known since last two decades. As hospitals and pharma industries, household medicines also need proper disposal otherwise they will gradually find their way into environment. So, we did a survey of residents in major metro city to understand their medicine wastage as well as disposal practices.
Results: The water samples screened for antibiotic presence were all negative from 10 locations. A total population of 749 people, from 165 houses were included in the study. Leftover medicines were found in 75.8% houses, of which 5.36% houses had leftover antibiotics. Garbage disposal (58.2%) was the most commonly observed method of medicine disposal. Good attitude towards proper antibiotic disposal was independently significant with higher education (OR=2.5, 95% CI= 1.05-6.17), employment (OR=2.1, 95% CI= 1.05-4.3), and upper middle-class families (OR=2.4, 95% CI= 1.08-5.21).
Conclusions: Lack of proper guidelines for household medicine disposal across the country is reflected in our community too. Although this study could not detect antibiotics in the canal water, the emerging resistance pattern across the state reflects it could be there. Therefore, immediate action on medicine waste collections needs to be implemented.

Keywords: Antibiotics, Antibiotic pollution, Household medicine, Medicine disposal, Surface water screening

INTRODUCTION

Drugs are now considered as mankind's basic need. Every house is now a mini pharmacy loaded with new and old drugs that includes vitamins, cough syrups, lozenges, pain killers, gels, ointment's, eye/ ear drops, antiseptics etc.[1] Self-discontinuation due to improvement in diseased condition, no improvement in the disease condition, side effects, non-compliance, increased cost and are most common reason for discontinuation.[1] This creates not only health issues but economic burden in terms of biomedical waste and money.

As our country lacks any proper disposal of household wastes, people find their own easy methods for disposal. In India garbage disposal along with other wastes is the most common method of household medicine disposal as seen in studies until now. Few people flush the waste medicines into toilet or sink and others burn it in open spaces too. Ultimately the medicines reach soil and from there they gradually leach into ground or surface water.

Hospital effluents are the next commonest sources for contaminating the water. Direct application of antibiotics in aqua culture farms are also potential sources for environmental contamination.[2] Uses of hormones in cattle and poultry farming can also reach soil and water through their excreta.[3] Mankind has started to detect the pharmaceuticals from environment since last three decade. A well-known example in India is the highly antibiotic polluted holy river in Madhya Pradesh.[4] Their consequences in other organisms are shocking. Fluoxetine induced developmental delay in tadpoles, feminization of male fishes due to oral contraceptive pills, diclofenac induced vulture death are the few examples.[5-7] Environmental contamination with antibiotics has become the known aetiology behind development of bacterial resistance. Vertical as well as horizontal transmission of antimicrobial resistant gene among organism is possible in highly polluted water bodies.

Recently, the Kerala University of Fisheries and Ocean Studies (KUFOS), showed a large presence of multidrug-resistant bacterial isolates including traces of New Delhi Metallo-β-lactamase 1 and Cephalosporin resistance genes from aquaculture farms in Kollam, Ernakulam and Kannur districts in Kerala.[8] These signals us about the next pandemic due to antimicrobial resistance.

Cochin is India one of the largest densely populated metro city. More than 35 multi-speciality hospitals are located within and around the city itself. The geographical richness of small and big water channels running across the city ultimately drains into the Cochin backwaters. All these factors are leading to pollution in all means especially the water bodies. When the garbage waste disposal possesses huge burden to the municipal corporation, house hold medicine disposal might be lacking or it may remain in infancy in the city. So, our objectives were focused to estimate the various drug disposal methods among the residents in the buffer zone of the major canals in the metro city.

METHODS

Study design for surface water screening

A cross-sectional observational study was conducted to test surface water samples from 5 major city canals in Kochi: Edappally Canal, Thevara - Perandoor Canal, Chilavannur Canal, Thevara canal and Market canal for the presence of selected antibiotics. Study was initiated after ethics committee approval from the institution. The research study protocol was maintained as per institution ethics committee (ECASM-AIMS-2021-006).

Data collection and water sample analysis

Water samples were collected on March 2021 from ten random convenient locations of these canals. 2500ml water was collected in an alcohol pre-washed non-sterile high-density polyethylene (HDPE) container using grab sampling technique based on U.S. Geological Survey Techniques of Water-Resources Investigations. The container was dipped into water from the centre of the canal. A marked rope was used to collect surface water from 30cm depth. The same procedure was repeated for the all 10 locations. A 250ml of surface water samples were collected from all the 10 locations and were stored for future references. The samples were then labelled and transferred in a cold box packed with icepacks to laboratory in Hyderabad within 24 hours of collection. Sample were extracted using suitable solvent as per our in-house designed method. The reconstituted sample was injected to LCMS/MS instrument (Shimadzu 8050, Kyoto, Japan) to detect the presence of individual antibiotics.

Study design for house survey

A questionnaire based cross sectional observational study was conducted in the residents residing in 20.5m buffer zone of these canals. all the five canals are located in different regions of Cochin city itself. The canals have divided into stretches based on length and breadth by Cochin Corporation. A total of 28 stretches are there for 5 canals with 1940 settlers in 20.5-meter buffer zone according to 2011 census. Out of 28 stretches, 16 stretches have houses more than 32 houses has considered as a cluster. The houses were visited from June 2021 to August 2021. After a brief description of study, written consent was obtained from the participant. Participants were requested to show their entire household medicines. The leftover medicines were sorted according to the predefined definition by investigators. Survey was initiated from random house in a cluster and then every 2nd house was visited.

Data collection

A 6-person validated, investigator prepared, preformed questionnaire was used as tool for interviewer-based house survey. Initial part included the personal and socio-demographic details of the participant. The primary method of disposal of medicines were assessed. The participants knowledge (K), attitude(A) and practices (P) on antibiotic usage and disposal were also evaluated.

Sample size

According to a study done in Northern Tamil Nadu, the prevalence of garbage disposal from households was found to be 51.4%[9]. With confidence interval of 95%, fixed precision of 10% and assuming a nonresponse rate of 10%, the sample size calculated was 159.

Statistical analysis

The variables were described in descriptive statistics like frequencies, percentages, mean and standard deviation. The various socio-demographic factors and their association with KAP of antibiotic usage and disposal

were studied using Chi-square test. Multivariate analysis was performed if more than one variable was significantly associated with outcome variable in bivariate analysis. The data was entered in Microsoft Excel and was analysed by using statistical software IBM SPSS Statistics 18.0 software (IBMCo., Armonk, NY). A p-value less than 0.05 was considered statistically significant.

RESULTS

The water samples were collected from 10 random locations of 5 major city canals. the samples were screened for tetracycline, sulfamethoxazole, ciprofloxacin, and ampicillin. The location code and limit of quantification is given in Table 1.

Table 1: Results of surface water screening for antibiotics.

Location code	Tetracycline (LOQ: 0.01 mg/kg) and its 4 epimers*	Sulfamethoxazole (LOQ: 0.005 mg/kg	Ciprofloxacin (LOQ: 0.01 mg/kg)	Ampicillin (LOQ: 0.01 mg/kg)
ED1	Not detected	Not detected	Not detected	Not detected
ED2	Not detected	Not detected	Not detected	Not detected
ED3	Not detected	Not detected	Not detected	Not detected
PER1	Not detected	Not detected	Not detected	Not detected
PER2	Not detected	Not detected	Not detected	Not detected
PER3	Not detected	Not detected	Not detected	Not detected
CH1	Not detected	Not detected	Not detected	Not detected
CH2	Not detected	Not detected	Not detected	Not detected
TH1	Not detected	Not detected	Not detected	Not detected
MKT1	Not detected	Not detected	Not detected	Not detected

*Oxy-tetracycline (LOQ-0.005mg/kg), chloro-tetracycline (LOQ-0.01mg/kg), 4-epimer tetracycline (LOQ-0.01mg/kg), 4-epimer chloro-tetracycline (LOQ-0.01mg/kg) and 4-epimer oxytetracycline (LOQ-0.01mg/kg). LOQ-Limit of Quantification. LCMS/MS-Liquid chromatography mass spectrometry

Table 2: Knowledge regarding antibiotics and antibiotic resistance (n=165).

Knowledge regarding antibiotic use and disposal	Strongly agree (%)	Agree (%)	Partly agree (%)	Disagree (%)	Strongly disagree (%)
Antibiotics is a prescription medicine	154 (93.3)	6 (3.7)	5 (3)	0	0
Antibiotics are indicated for common cold	85 (51.5)	60 (36.3)	9 (5.5)	7 (4.2)	4 (2.5)
Antibiotics are given as a course and need to complete without stopping	78 (47.3)	56 (33.9)	21 (12.7)	10 (6.1)	0
Self-antibiotic medication can cause antibiotic resistance	14 (8.5)	12 (7.3)	8 (4.8)	26 (15.8)	105 (63.6)
Antibiotics or antibiotic prescription shall not share among others	101 (61.2)	17 (10.3)	12 (7.3)	19 11.5)	16 (9.7)
Bacteria can develop resistance to antibiotics if not used properly	6 (3.7)	3 (1.8)	9 (5.5)	37 (22.4)	110 66.6)

A total of 165 houses were included in the house survey. Average no of members in a house hold was 5. The total study population was 749. All the houses were located under Cochin corporation, which is semi urban to urban area, alongside the city canals. Most of the participants were females (58.2%). There were 75.2% were above 40 years. Mean age of the participants was 51.6 years. 18-year-old student was youngest participant. On enquiring regarding expiry of drugs, 95% are aware and 11% regularly check before consumption. Approximately half (48.7%) of them were not aware of its consequences. The knowledge, attitude and practices regarding antibiotic medication is showed in Table 2-4 respectively.

Good attitude was statistically significant with in terms of education (p=0.002), occupation (p=0.021) and per capita income (p=0.005). Multivariate logistic regression analysis on factors associated with attitude about antibiotic usage showed education, occupation and monthly income were independently significant with good attitude (Table 5). Multivariate logistic regression analysis showed upper middle-class families (≥3504 INR) have 2.7 times better practice than families with <3503 INR per month on good antibiotic medication practices (Table 6).

Table 3: Assessment of 'Attitude' on antibiotic medication (n=165).

Attitude towards antibiotic medication	Strongly agree (%)	Agree (%)	Partly agree (%)	Disagree (%)	Strongly disagree (%)
I believe that antibiotics are prescribed only by registered medical practioner	98 (59.4)	49 (29.7)	18 (10.9)	0	0
I know that antibiotics are prescribed only when it is indicated	100 (60.6)	43 (26.1)	21 (12.7)	1 (0.6)	0
I believe that complete course has to be taken	80 (48.5)	39 (23.6)	37 (22.4)	5 (3)	4 (2.5)
I think self-medication is not good	1 (0.6)	16 (9.7)	91 (55.2)	55 (33.3)	2 (1.2)
I know that if antibiotics are not disposed correctly, they can pollute soil/water/air	1 (0.6)	7 (4.2)	70 (42.5)	74 (44.9)	13 (7.8)
I know that proper disposal is needed for antibiotics because it can cause antibiotic resistance	5 (3)	4 (2.5)	61 (37)	77 (46.7)	18 (10.8)

Table 4: Assessment of 'Practice' on antibiotic medication (n=165).

Antibiotic medication practices	Strongly agree (%)	Agree (%)	Partly agree (%)	Disagree (%)	Strongly disagree (%)
I always consult a doctor before antibiotic medication	162 (98.2)	3 (1.8)	0	0	0
I always complete the antibiotic course as per doctor's prescription	126 (76.4)	33 (20)	6 (3.6)	0	0
I have bought antibiotics directly from pharmacy without prescription	0	0	7 (4.2)	12 (7.3)	146 (88.5)
I can share leftover antibiotics with friends, family members or neighbours etc.	0	0	0	7 (4.2)	158 (95.8)
I can reuse antibiotic prescription	0	0	1 (0.6)	11 (6.7)	153 (92.7)

Table 5: Multivariate logistic regression analysis of attitude on antibiotic medication.

Sociodemographic variables		Regression coefficient	SE	Wald	Odds ratio	95% C.I. for Odds ratio		P value
						Lower	Upper	
Education	<Graduation	-	-	-	1.000	-	-	0.039*
	≥Graduation	0.934	0.452	4.278	2.545	1.050	6.169	
Occupation	Unemployed	-	-	-	1.000	-	-	0.035*
	Employed	0.755	0.359	4.430	2.127	1.053	4.295	
Per capita income [#] (monthly)	<3503 INR	-	-	-	1.000	-	-	0.030*
	≥3504 INR	0.867	0.400	4.692	2.379	1.086	5.211	

*p value <0.05 is significant, #Modified BG Prasad socioeconomic scale 2019 update, SE-Standard error, CI- Confidence Interval

Upon drug collection, 75.8% houses had leftover medicines, of which 38% stored for reuse, and 32% has planned to dispose and 1% return to pharmacy to charity. The leftover medicines were classified based on their main use into antipyretics, analgesics, antidiabetic drugs etc (Figure 1). 392 different classes of leftover medicines were identified from 165 houses. Leftover antibiotics were found in 5.36% (n=392). Among the left-over antibiotics, amoxicillin and amoxicillin + clavulanic acid combination tablet strips were found in 47.6% and 14.3% respectively.

Self-discontinuation of the antibiotic treatment was noted in 24%, of which 10% discontinued due to improvement in disease, 10% due to fear of adverse effects and 4% due to development of side effects. Allopathic medications in all dosage forms (tablets, capsules, gels, ointment, solutions, suspensions, aerosols, sprays etc) were disposed along with other household solid wastes were practiced by 58.2% (n=165). These were later collected periodically by corporation. Throwing into soil and applying as fertilizers in their premises were practiced by 27.9% of families. Burning medicines with other solid

wastes in their premises were noted in 10.9% of houses. Discarding into drainage-sink/flush, is seen in 3% houses. There was no statistical significance with sociodemographic profile with any methods of medicine disposal.

Table 6: Multivariate logistic regression analysis of antibiotic medication practice.

Sociodemographic variables		Regression coefficient	SE	Wald	Odds ratio	95% C.I. for Odds ratio		p-value
						Lower	Upper	
Education	<Graduation	-	-	-	1.0	-	-	0.058
	≥Graduation	2.000	1.057	3.582	7.389	0.931	58.618	
Per capita income[#] (monthly)	<3503 INR	-	-	-	1.0	-	-	0.049*
	≥3504 INR	0.992	0.505	3.865	2.697	1.003	7.252	

*p value <0.05 is statistically significant, #Modified BG Prasad socioeconomic scale 2019, SE-Standard Error, CI-Confidence Interval

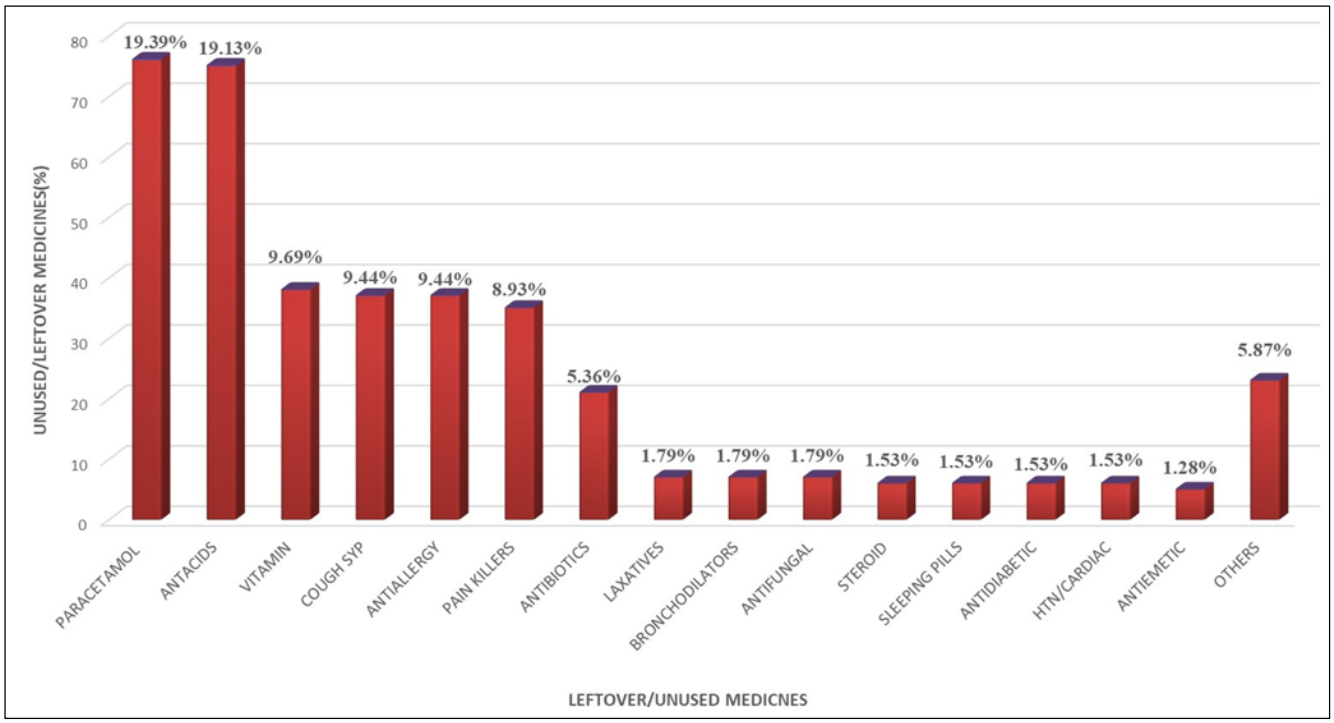

Figure 1: Bar diagram of leftover medicines according to the use.

DISCUSSION

Surface water screening for antibiotics

All samples were negative for the tested antibiotics - tetracycline, oxy-tetracycline, chloro-tetracycline, 4-epimer tetracycline, 4-epimer chloro-tetracycline, 4-epimer oxytetracycline, ciprofloxacin, sulphamethoxazole and ampicillin.

Surface water sample studies for antibiotics by Li et al and Ding et al in China, Azanu et al in Ghana and Catrignano et al in Vietnam found similar antibiotics in nanogram concentration.[10-13] Hot spot sampling from the waste water discharge point from hospitals, pharmaceutical companies and municipal waste water receiving sites of sewage treatment plant were the locations in other studies.[14] Moreover, environmental factors like seasonal variations, high/low tides, chemical and physical properties of antibiotics will influence their concentration. Therefore, to detect them we need highly sensitive advanced equipment's.

House survey for medicine wastage and disposal practices

In our study 3 out of 4 houses had leftover medicines. A study in rural parts of West Bengal found 67.1% households with leftover medicines.[1] Among them, paracetamol (tablets, drops, syrups etc) was common findings were similar in Maharana et al and Auta et al.[1,15] It was expected that, as the study was conducted in the second wave of Covid-19 outbreak, houses were loaded with antipyretics.

Most common method of household drug disposal was dumping into garbage (58.2%). Shockingly few have mentioned about using medicines as fertilizers which help in flowering. Burning (10.9%) was also practiced among few participants in their premises. Most of studies in other states of India noted majority practices disposing medicines into household trashes.[16] Other methods like threw away out of the house, flushing in toilet, throwing into nearby water bodies, burning and spraying to plants also practices elsewhere.[17,18] Hence, we conclude that lack of proper disposal practices across the country reflects in our community too. This requires an urgent attention in national level for implementation of strict laws as well as action plans.

Knowledge, attitude and practices towards antibiotic usage and disposal

Our surveyed community has adequate level of knowledge on antibiotics. Similarly, studies in Saudi Arabia and Indonesia also showed average level of knowledge among the citizens.[19,20] Merely 6% families have understanding about antibiotic resistance which was similar in India and Kuwait.[21,22] To surprise us a study on 94.9% of general population in Germany were aware of multidrug resistant pathogen.[23] It is high time and indeed the duty of health sector workers to disseminate information to highly educated community about antibiotic resistance and its consequences.

Majority of participants had good attitude towards antibiotic use. Regarding the antibiotic disposal, their attitude was not adequate as they received no education regarding this. Inappropriate practices in terms of early discontinuation (33%), reuse of old prescription (7%) and sharing (4%) of antibiotics were also noted despite adequate knowledge and attitude about antibiotic use. All these shows that this is a highly receptive community in terms of high level of education, occupation and income but their knowledge, attitude and practices are still not up to the mark.

Keeping drug collection in pharmacies or hospitals also showed lots of concerns by the surveyed community in terms of fraud reselling of drugs, impracticality of programs, funding issues, lack of interest by authorities. This shows that any new step in this matter is really challenging. A proper education regarding medicine disposal in inevitable. We are sure that people will accept good fruitful approaches such like ‘PROUD’, ‘Medicine Baba’ etc. which works here as well.

CONCLUSION

Thus, we conclude that Pharmaceuticals can reach the environment via various methods. Therefore, strict drug disposal strategies and regulations have to maintained in the country from pharmaceutical industries, hospitals, veterinary hospitals, animal husbandry, aqua culture farms and in households. We found that the surveyed community has never received any education on safe drug disposal. Government agencies or collaborative public-private partnership or non-governmental organizations or co-corporate sectors could put up on ‘Community drug waste collection’ drives. Such measures would allow for sorting of drugs within expiry and maybe given for charity.

ACKNOWLEDGEMENTS

We would like to thank Vimta Labs Ltd, Hyderabad for the technical assistance in water sample analysis.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee (ECASM-AIMS-2021-006)

REFERENCES

1. Maharana S, Paul B, Dasgupta A, Garg S. Storage, reuse, and disposal of unused medications: A cross-sectional study among rural households of Singur, West Bengal. Int J Med Sci Public Heal. 2017;3(1):11-15
2. Amlund H, Berntssen MHG, Lunestad BT, Lundebye AK. Aquaculture feed contamination by persistent organic pollutants, heavy metals, additives and drug residues. Anim Feed Contam Eff Livest Food Saf. 2012;205-29.
3. Baudoin F, Hogeveen H, Wauters E. Reducing antimicrobial use and dependence in livestock production systems: a social and economic sciences perspective on an interdisciplinary approach. Front Vet Sci. 2021;8:584593.
4. Diwan V, Purohit M, Chandran S, Parashar V, Shah H, Mahadik VK, et al. A three-year follow-up study of antibiotic and metal residues, antibiotic resistance and resistance genes, focusing on Kshipra-A river associated with holy religious mass-bathing in India: Protocol paper. Int J Environ Res Public Health. 2017;14(6).
5. Foster HR, Burton GA, Basu N, Werner EE. Chronic exposure to fluoxetine (Prozac) causes developmental delays in Rana pipiens larvae. Environ Toxicol Chem. 2010;29(12):2845-50.
6. Zuccato E, Castiglioni S, Fanelli R, Bagnati R, Reitano G, Calamari D. Risks related to the discharge of pharmaceuticals in the environment: further research is needed. Pharm Environ. 2004;431-7.
7. Oaks JL, Gilbert M, Virani MZ, Watson RT, Meteyer CU, Rideout BA, et al. Diclofenac residues as the cause of vulture population decline in Pakistan. Nature. 2004;427(6975):630-3.
8. Kalasseril SG, Krishnan R, Vattiringal RK, Paul R, Mathew P, Pillai D. Detection of New Delhi Metallo-β-lactamase 1 and cephalosporin resistance genes among carbapenem-resistant enterobacteriaceae in water bodies adjacent to

hospitals in India. Curr Microbiol. 2020;77(10):2886-95.
9. Hithesh I, Nisha B TJ. Practice of storage, reuse and disposal of unused medications among semi-urban households of Northern Tamil Nadu – a community based cross-sectional study. Int J Res Pharm Sci. 2020;11(2):1902-7.
10. Li N, Zhang X, Wu W, Zhao X. Occurrence, seasonal variation and risk assessment of antibiotics in the reservoirs in North China. Chemosphere. 2014;111(9):327-35.
11. Azanu D, Styrishave B, Darko G, Weisser JJ, Abaidoo RC. Occurrence and risk assessment of antibiotics in water and lettuce in Ghana. Sci Total Env. 2018;622:293-305.
12. Ding H, Wu Y, Zhang W, Zhong J, Lou Q, Yang P, et al. Occurrence, distribution, and risk assessment of antibiotics in the surface water of Poyang Lake, the largest freshwater lake in China. Chemosphere. 2017;184:137-47.
13. Castrignanò E, Kannan AM, Feil EJ, Kasprzyk-Hordern B. Enantioselective fractionation of fluoroquinolones in the aqueous environment using chiral liquid chromatography coupled with tandem mass spectrometry. Chemosphere. 2018;206:376-86.
14. Diwan V, Tamhankar AJ, Khandal RK, Sen S, Aggarwal M, Marothi Y, et al. Antibiotics and antibiotic-resistant bacteria in waters associated with a hospital in Ujjain, India. BMC Public Health. 2010;10.
15. Auta A, Omale S, Shalkur D, Abiodun AH. Unused medicines in Nigerian households: Types and disposal practices. J Pharmacol Pharmacother. 2011;2(3):195-6.
16. 16. Zalpuri R, Singh R, Rawat L, Sharma JK. Review on the status of disposal practices of unused and expired medicines in India. Int J Innov Sci Eng Technol. 2021;8(3).
17. Sonowal S, Desai C, Kapadia J, Desai M. A survey of knowledge, attitude, and practice of consumers at a tertiary care hospital regarding the disposal of unused medicines. J Basic Clin Pharm. 2017;8(1):4.
18. Narwat A, Sindhu A. Practice towards disposal of medicines (unused/expired drugs) among the patients visiting tertiary care teaching hospital in Haryana, India. Int J Res Med Sci. 2019;7(8):3050.
19. Alkhalifah HM, Alkhalifah KM, Alharthi AF, Elzahrany YR, Aljuhani MA. Knowledge, attitude and practices towards antibiotic use among patients attending Al Wazarat health center. J Fam Med Prim Care. 2022;11(4):1299-307.
20. Karuniawati H, Hassali MAA, Suryawati S, Ismail WI, Taufik T, Hossain MS. Assessment of knowledge, attitude, and practice of antibiotic use among the population of boyolali, indonesia: A cross-sectional study. Int J Environ Res Public Health. 2021;18(16).
21. Awad AI, Aboud EA. Knowledge, attitude and practice towards antibiotic use among the public in Kuwait. PLoS One. 2015;10(2):1-15.
22. Bhardwaj K, M SS, Baliga S, Unnikrishnan B, Baliga BS. Knowledge, attitude, and practices related to antibiotic use and resistance among the general public of coastal south Karnataka, India – A cross-sectional survey. Clin Epidemiol Glob Heal. 2021;11(October 2020):100717.
23. Raupach-Rosin H, Rübsamen N, Schütte G, Raschpichler G, Chaw PS, Mikolajczyk R. Knowledge on antibiotic use, self-reported adherence to antibiotic intake, and knowledge on multi-drug resistant pathogens -results of a population-based survey in lower saxony, Germany. Front Microbiol. 2019;10(APR):1-8.

Cite this article as: David R, Jayachandran M, Palatty PL. A study on household medicine wastage and disposal practices with screening of water samples for antibiotic presence in a South Indian district. Int J Community Med Public Health 2024;11:2787-93.