Assessing the Relationship of Public Risk Perception Regarding Environmental Impacts of Pharmaceutical Handling with Knowledge, Attitude, and Practices in Abuja, Nigeria: A Cross-Sectional Study

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Abstract- ***the presence of pharmaceuticals in the environment has been a source of concern that caught the attention of global environmental players. This concern is mainly because of the risk associated with household methods of handling pharmaceuticals. The main objective of this study was to determine the relationship between public risk perception and knowledge, attitude, and practices regarding the environmental impacts of pharmaceutical handling in Abuja, Nigeria. Materials and Methods: The study conducted a cross-sectional survey using a structured self-administered questionnaire among 2,182 participants between March 2019 through June 2019. The data were analyzed using descriptive, chi-square, and independent t-test methods. Results: The majority of the respondents 1460 (66.9%) had a good level of knowledge, 1337 (61.3%) indicated a negative attitude, most of them exhibited unsafe practices 2095 (96.0%), and 1234 (56.6%) perceived high risk. The demographic factors associated with risk perception were area council, educational level, occupation, and medical history (p=0.001). Household income showed an association among those with low (Mean ± SD; 24.33 ± 2.54) and high (34.44 ± 4.55) risk perception. Likewise, knowledge and attitude are associated (p=0.001) with risk perception. Conclusion: The study concluded that the environmental impacts of pharmaceuticals, as well as risk perception, are determined mainly by public knowledge, attitudes, and practices regarding pharmaceutical handling. Thus, it is recommended that efforts towards attitudinal change are imperative through health professionals and media participation to save the environment. Again, legislation on regulatory frameworks to prevent and control pharmaceutical pollution from the point sources to limit the environmental impacts of pharmaceuticals is necessary.***

Indexed Terms- ***Risk Perception, KAP, Pharmaceuticals, Pharmaceutical Handling, Abuja***

I. INTRODUCTION

The presence of pharmaceuticals in the environment has drawn the attention of the scientific community, policy, decision-makers, and environmental and risk managers globally. Pharmaceuticals are emerging pollutants of concern that span three decades with less attention in developing nations of Africa, such as Nigeria (Glassmeyer et al. 2009; Hs, Chakraborty, and Virupakshaiah 2015; K'oreje et al. 2016). Widespread pharmaceuticals have been discovered in various environmental matrices fresh and marine waters, groundwater, wastewater sludge, sewages, soils, plants, and animals) (Ang'ienda 2017; Daughton 2014; Saby et al. 2017; Tijani, Fatoba, and Petrik 2013; Yan et al. 2014). Studies reported the most outstanding results are the prevailing global concentrations of numerous pharmaceutical substances for the aquatic environment that are within the range identified to cause ecotoxic effects in marine systems (Bu et al. 2016; Daughton 2014; Lapworth et al. 2017; Montastruc et al. 2016; Wee and Aris 2017a). For example, the population declines almost to the extinction of vulture species in Pakistan due to the birds preying on the treated dead animals with the non-steroid anti-inflammatory drug diclofenac (Oaks et al.

2004). Diclofenac could damage the inner organs of rainbow trout in aquatic systems (Beek et al. 2016).

Recent studies reported that active pharmaceutical ingredients (APIs) have the potential ecological risk even in low concentrations (Bai et al. 2018). However, one of the primary sources and routes of pharmaceuticals into the environment are household handling practices such as the use, storage, and disposal of unused or expired medicines. These improper practices could pose a severe risk to human health as well as the environment (Bound et al., 2006). Drugs consumed by patients for human use or medicines used for animals such as veterinary medications, hospitals, and manufacturing effluents are another source of contamination. Humans can defecate Pharmaceuticals as the parent compound or metabolites in urine and feces. Many pharmaceuticals widely used in human medicine are excreted unaltered or as active metabolites in large proportions and continuously released into domestic wastewater (Deo and Halden 2013; Tijani et al., 2013; Verlicchi et al., 2010). A large quantity of pharmaceuticals in the aquatic environment comes from the improper disposal of unwanted expired drugs from households and hospitals. The unused and expired pharmaceuticals are flushed down the toilets/sinks or thrown into the garbage. "Take-back" programs, are the safest method of disposal in which people return unwanted or expired drugs to a central collection center for adequate disposal, but unavailable, and people have few options (Angi'enda and Bukachi, 2016; Ayele and Mamu, 2018; Nipa et al, 2017; Oyer, 2013; Wu, 2010; Yang et al., 2018). Several pharmaceuticals can, therefore, get to Sewage Treatment Plants in substantial quantities and, if they escape degradation, can gain entry into surface water. Most Waste Water Treatment Plants WWTPs) cannot remove completely pharmaceutical compounds, which drain into surface waters, and eventually into groundwaters (Brandmayr et al. 2015; Huang et al. 2014).

Therefore, this could pose a severe risk to human health and the environment (Jonathan P. Bound et al., 2006). However, because of the ubiquitous nature of these compounds, over 600 different pharmaceutical ingredients have been discovered to be present in the environment globally (Beek et al. 2016; Kuster and Adler 2014; Weber et al. 2014). The main classes of pharmaceuticals found to occur in the environment are animal and human antibiotics, beta-blockers, non-steroidal anti-inflammatory drugs, hormones, lipid regulators, and anti-depressant drugs (Res et al. 2018; Rogowska et al. 2019; Shaaban 2018). Frequent discharge of these substances into the environmental compartments could result in long- exposure leading to chronic risk to humans and wildlife (Daughton 2010).

Many studies recently reported that active pharmaceutical ingredients (APIs) have the potential environmental risk even at low concentrations (1 ng/L), which may have detrimental effects on aquatic species such as impairment of sexual development and feminization of fish. (Bai et al. 2018; Wee et al. 2020). It was revealed that fish exhibit sensitivity when exposed to different steroid estrogens, natural and synthetic (ethinylestradiol) by demonstrating intersex behaviors, signifying those steroid estrogens caused feminization in the fish (Wee and Aris, 2017; Zaharin et al., 2014). Therefore, for effective risk management, actions aimed at reducing the number of pharmaceuticals that enter the environment, especially the water bodies should appreciate the motivation behind that behavior and practices. Improper pharmaceutical handling contributes substantially to environmental pollution and medication wastage (West et al. 2016). To the knowledge of the researcher, no published research to date has studied the relationship between public risk perception regarding the environmental impacts of pharmaceuticals and KAP in Abuja, Nigeria.

Water pollution is an acute global problem that urgently requires attention. The UN estimates that the quantity of wastewater produced yearly is six times more than the water present in all the rivers of the world, which is around 1500 km3 (UN WWAP 2003). Lack of adequate sanitation causes water resource contamination globally, making it one of the most important causes of water pollution. About 4.5 billion persons are surviving in the absence of proper sanitation worldwide (UNICEF 2017). Geissen et al. reported that over 50% of natural freshwater fish species and nearly one-third of the global amphibians are at risk of extinction (Geissen et al. 2015). Therefore, for effective management of risk, actions

aimed at reducing the number of pharmaceuticals that enter the environment, especially the water bodies, should appreciate the motivation behind that behavior and practices. These inappropriate practices result in substantial environmental as well as health challenges such as antibiotic resistance, sex interchange, and sexual impairment, which could lead to ecological disasters, etc. (Celik et al., 2013; Homedes and Ugalde 2001). Unfortunately, adequate and organized policies are lacking in this respect in the developing world.

The association between risk perception and behavior is complicated (Jonathan P Bound et al., 2006). A study established a weak relationship between risk perception and knowledge when it concerns natural hazards (Wachinger et al. 2013). Research suggests the likelihood of risk perception differs among different societies because risks are amplified and attenuated by news media in different ways. It also depends on what the media want to tell people, the opinions of the public, cultural norms, technical, and existing legal framework for the control, and regulation of risk factors (Cediel et al. 2012). Consequently, the study hypothesized that risk perception influences the knowledge, attitude, and practices (KAP) as well as socio-demographic factors. This study aimed to analyze the relationship between risk perception and KAP and to identify the factors that influence the perception of risk among Abuja residents. This information may help improve strategies of risk communication and proactively prevention of pharmaceutical pollution from the point sources.

Understanding the specific factors influence the risk perception is central to appreciating how people will respond to the environmental impacts of pharmaceuticals. There are numerous advantages to the pragmatic study of risk perception among the general public. This work provides a better understanding of how risk perception influences KAP. It gives awareness of how risk perception impacts several behaviors and practices; it allows for the mapping of spatial risk perception; it necessitates the development of effective communication and education programs, and it is convenient for identifying which factors contribute to perceived risk.

II. MATERIALS AND METHODS

Study design and description of study settings

The study was a cross-sectional structured questionnaire survey among residents of Abuja communities in Nigeria between March 2024 and June 2024 to elucidate information on how the public perceives the environmental impacts of Pharmaceuticals as a result of handling practices.

III. POPULATION

The study population comprised all the heads of the households or their representatives who attained the age of at least eighteen (18) years and above. At this age, people are considered reasonable enough to respond to questions regarding pharmaceutical handling and its impacts on the environment in the Abuja Federal Capital Territory (FCT) of Nigeria (Bashaar et al. 2017). The National Population Census of 2006 (NPC, 2006), gave the total population of Abuja and its environs to 1,405,201 and is projected to be over 3.2 million persons by the year 2024 with an estimated growth rate of 5.91% per annum increase from 2023 (Mohammed, Othman, and Osman 2019; UN 2018). The total households in Abuja are 625,285 (Nigeria National Bureau of Statistics, 2015).

Sample size determination and sampling technique

This study used Daniel's formula to determine the sample size (Daniel and Cross 1999). The consideration of this method was due to a large number of the population involved. Where; n is the sample size, Z is the statistic corresponding to the level of confidence, P is the expected prevalence (obtained from the same studies or a pilot study conducted by the researchers), and d is precision (corresponding to effect size). The confidence level is 95% because most studies adopt a 95% confidence interval (CI) to present their results. Based on the stated assumptions, the final calculated sample size was 2,618, accounting for an assumed non-response rate of 10%. However, the allocation of the sample was not proportionate to each area council surveyed because the sample size for each area council was determined separately (Table 1).

Table 1: Sample Distribution According to Area Councils of Abuja

Area Council	Household	Percentage	Sampled	Respondent	Percentage
AMAC	345,181	55%	399	366	16.8
Bwari	101,947	17%	398	378	17.3
Kuje	43,234	7%	396	285	13.1
Abaji	26,075	4%	392	380	17.4
Gwagwalada	70,529	11%	400	400	18.3
Kwali	38,317	6%	395	373	17.1
Total	625,283	100	2,618	2182	100.0

The study adopted a multi-stage using a two-stage sampling method. First, was a selection of two districts each through a simple random sampling technique from the six area councils of the federal capital: Abuja Municipal Area Council (AMAC), Abaji, Bwari, Gwagwalada, Kuje, and Kwali. In the study unit, households were selected using a systematic random sampling technique. The study administered the structured KAP questionnaire to the heads of households or any resident who is 18 years and older. The World Health Organization (WHO) encourages the use of the KAP approach as a data collection tool in a questionnaire survey, especially in a prevention-related study (Cediel et al. 2012; Tabash et al. 2016).

Questionnaire Design

A questionnaire was developed after an extensive review of related literature and content validity with a panel of nine experts in the field of pharmacy practice as well as the environment. The recommendations given by the panelists were used to produce the final version of the questionnaire. The 69-item instrument contained six sections with section A, consisting of nine items, and obtained information on respondents' demographic characteristics such as gender, age, marital status, education, occupation, household size, income, and medical diagnosis record of the respondents. Sections B, C, and D, focused on respondents' knowledge, attitude, and practices and contained 11, 11, and 29 items, respectively. Section E has ten items that asked questions on respondents' risk perception of improper handling practices, and section F has six items that asked questions about the respondents' risk perception regarding the environmental impacts of the pharmaceutical residues in the environment of Abuja. The questionnaire comprised both open and close-ended questions, except for section A, which is the socio-demographic factors. All the sections were on a 5-point Likert scale. However, sections E and F, which were psychometric in approach, were merged to provide a more explicit analysis of the risk perceptions. The validated questionnaire was pilot-tested on 40 residents of Nyanya village in the Garki district of Abuja, which does not form part of the actual survey. The instrument was validated by professional experts and experienced pharmacists, environmentalists, human ecologists, psychometrics, and educational measurement. The Lushes' Content Validity Ratio (CVR) value for each item retained for the nine (9) experts was between 0.788 and 1.0, and the content validity index (CVI) value was 0.788, above the threshold for retaining the instrument as valid (Ghazali et al. 2018; Lawshe 1975). The Alpha Cronbach values for constructs' reliability are presented in (Table 2).

Table 2: Reliability test for the study instrument presenting Cronbach's Alpha results

S/no.	Constructs	Cronbach's Alpha	No. of items
1	knowledge	0.856	11
2	Attitude	0.976	11
3	Practices	0.827	29
4	Risk perception	0.844	16

IV. DATA COLLECTION

The validated questionnaire was self-administered to the respondents face-to-face by twelve research assistants who were university graduates working with the National Program on Immunization. They have undergone a three-day training by the lead researcher on the necessary research protocols before being dispatched to the field for data collection in their respective assigned areas. The enumerators were

assigned to the districts in which they were well familiar with for well-organized data collection. To ensure correct protocol was adhered to for the survey, the lead researcher aside from providing field supervision to the enumerators, also retrieved the completed questionnaires periodically. The respondents who could not read and write were supported by the researchers, while the literate ones responded to the questions without any support. There was no dropout of the study, except for the cases of incomplete responses. However, the total number of valid completed questionnaires was 2,182, which accounts for a response rate of 87.3%.

V. DATA ANALYSIS

The researchers analyzed the data using descriptive and inferential statistics techniques in Statistical Package for Social Sciences, SPSS (version 25). The study categorized the outcome variable and independent variables to determine their levels and used chi-square statistical tests to assess the relationship at 95% CI (P = 0.05). However, independent t-tests at (5% df and P = 0.05) were used to analyze continuous variables, such as age, household size, and household gross monthly income of the respondents. The dependent variable (risk perception) was categorized into two groups: low and high. In contrast, independent variables were categorized into poor and good for knowledge, negative and positive for attitude, and unsafe and safe for practices, respectively. The outcome variable was coded 0 for low and 1 for high for statistical analysis.

VI. ETHICAL CONSIDERATIONS

Their consent was sought before the commencement of the surveys. Likewise, permission was asked at the community level from the Chiefs, Districts Heads, or any titleholder in charge of the community before embarking on the survey. The respondents' consent/willingness to participate in the study was sought and were assured of anonymity, and utmost confidentiality in the information they provided. Similarly, we explained to the respondents that they could decide to drop out of the study at any given time.

VII. RESULTS

Level of Knowledge, Attitude, and Practices

Table 2, the overall level of the respondents' knowledge of pharmaceutical handling. Approximately two-thirds (66.9%) of the respondents had good knowledge, while one-third (33.1%) exhibited poor knowledge of pharmaceutical handling. The majority of the respondents (61.3%) demonstrated a negative attitude toward handling pharmaceuticals, while only (38.7%) exhibited a positive attitude. In terms of practices, a large number of respondents exhibited unsafe practices (96.0%), while only (4.0%) exhibited safe handling practices. The majority of the respondents (56.6%) perceived high risk, while only (43.4%) perceived low risk among the respondents regarding the environmental impacts of pharmaceutical handling practices.

Table 2: Level of Risk Perception, Knowledge, Attitude, and Practices Regarding Pharmaceutical Handling

Factors	Frequency	percentage
Knowledge		
Poor	722	33.1
Good	1460	66.9
Attitude		
Negative	1337	61.3
Positive	845	38.7
Practices		
Unsafe	2095	96.0
Safe	87	4.0
Risk perception		
Low	984	43.4
High	1234	56.6

Relationship between Risk Perceptions on Environmental Impacts of Pharmaceutical Handling and Socio-demographic Factors

Table 3 shows the relationship between socio-demographic factors and risk perceptions on the environmental impacts of pharmaceutical handling. The factors associated with risk perceptions on environmental impacts included Area council ($\chi2$=385.779, df =5, p=0.001), educational level of respondents ($\chi2$=59.517, df =5, p=0.001), occupation

of the respondents ($\chi 2$=41.756, df =5, p=0.001), and medical history ($\chi 2$=40.106, df =1, p=0.001). There was a significant association between the means of respondents' household income among those with low (Mean ± SD; 24.33 ± 2.54) and high (34.44 ± 4.55) risk perception on environment impacts of pharmaceutical handling. However, there was no association between respondents' age, gender, household size, and risk perceptions on the environmental impacts of pharmaceutical handling.

The results show that the respondent in AMAC that had higher risk perception were 213(9.8%) compared to those with low-risk perception, 153(7.0%). Likewise, the respondents that had higher risk perception in Bwari were 313(25.3%) than those with low risk, 65(6.9%). However, in Kuje, the respondents who had lower risk perception were more 155(7.1%) compared to those with a higher risk of about 130(6.0%). Furthermore, the respondents Abaji that had higher risk were 243(11.1%), and those that had lower risk constitute 137(6.3%). The respondents who had higher risk in Gwagwalada were 272(12.5%) while those with lower risk were 128(5.9%). The respondents in Kwali that perceived higher were far less 64(2.9%) compared to those that had lower risk perception on the environmental impacts of pharmaceutical handling Risk perception between gender shows that among male respondents, those that had higher risk were 640(29.3%) compared to those with lower risk 477(21.9%). While among the female respondents, those that had a higher risk of about 595(27.3%) were more compared to those that perceived lower risk 470(21.5%). Additionally, in terms of the educational level of the respondents, among those who did not attain school, those that had lower risk perception were more compared to those that had perceived higher risk. While on the contrary, among the respondents with Primary, Secondary, Diploma/NCE, Bachelor, and Postgraduate education, those that perceived higher risk compared to the respondents that perceived lower, respectively.

The findings also show that among the different occupations of the respondents, Civil service, Artisans, Business, Pension, and Housewife perceived higher risk compared to the respondents with lower risk. Except among respondents who are farmers, those that perceived risk lower 140(6.4%) were more compared to the respondents that had a high-risk perception of 110(5.0%). Similarly, medical diagnose history of the respondents shows among those that answered positive, the respondents who perceived higher risk were 570(26.1%) compared to those with a low-risk perception 310(14.6%), while those that were diagnosed any sickness, those that had higher risk perception 665(30.5%) compared to the ones lower risk perception 637(29.2%). In respect to the respondents' age, those with the mean age of 37.20 years perceived lower risk compared to those with the mean age of 35.79 years who perceived higher risk. Likewise, the household with the mean family size of 6.69 persons perceived lower risk compared to the household with the average family size of 6.03 who had higher risk perception. Also, the household gross monthly income of the respondents indicates that those with the mean monthly income of ₦96328.34 perceived higher risk compared to those with the mean monthly income of ₦75952.36 who perceived lower risk.

Table 3: Relationship between Risk Perceptions on Environmental Impacts of Pharmaceutical Handling and Socio-demographic Factors

Variable	Category	Low risk	High risk	$\chi 2$	df	P-value
Area council	AMAC	153(7.0%)	213(9.8%)	385.779	5	0.001
	Bwari	65(6.9%)	313(25.3%)			
	Kuje	155(7.1%)	130(6.0%)			
	Abaji	137(6.3%)	243(11.1%)			
	Gwagwalada	128(5.9%)	272(12.5%)			
	Kwali	309(14.2%)	64(2.9%)			
Gender	Male	477(21.9%)	640(29.3%)	452	1	0.285

	Female	470(2.5%)	595(27.3%)			
Educational level	Never school	241(11.0%)	196(9.0%)	59.517	5	0.001
	Primary Education	53(2.4%)	67(3.1%)			
	Secondary Education	309(14.2%)	342(15.7%)			
	NCE/ Diploma	201(9.2%)	321(14.7%)			
	Bachelor	104(4.8%)	224(10.3%)			
	Postgraduate	39(1.8%)	85(3.9%)			
Occupation	Business	333(15.3%)	381(17.5%)	41.756	5	0.001
	Housewife	205(9.4%)	259(11.9%)			
	Farming	140(6.4%)	110(5.0%)			
	Artisan	47(2.2%)	62(2.8%)			
	Civil service	207(9.5%)	383(17.6%)			
	Pension	15(0.7%)	40(1.8%)			
Med. diagnose history	Yes	310(14.6%)	570(26.1%)	40.106	1	0.001
	No	637(29.2%)	665(30.5%)			
		Mean ± SD		T stat	df	Sig.
Age (years)		37.20 ± 11.36	35.79 ±11.91	2.812	2180	0.148
Household size		6.69 ±3.252	6.03± 3.271	4.646	2180	0.752
Monthly income (₦)		75858.61 ± 75952.36	96328.34 ± 112815.78	4.810	2180	0.001

Relationship between Risk Perceptions on Environmental Impacts of Pharmaceutical Handling and KAP.

There was a statistically significant relationship between risk perception on the environmental impacts of pharmaceutical handling and respondents' knowledge, ($\chi2$=590.194, df =1, p=0.001) and respondents' attitude, ($\chi2$=164.704, df =1 and p=0.001). However, there was no statistically significant relationship between risk perceptions and respondents' practices (Table 4). Therefore, among the respondents who had poor knowledge, those who perceived higher risk were less 144(6.6%) compared to the respondents who perceived lower risk 574(26.5%), while among those that had good knowledge, respondents with a high-risk perception were 1091(50.0%) compared to those with a low-risk perception 369(16.9%). Similarly, among the respondents who exhibited a negative attitude, those who had a low-risk perception were 725(33.2%), and the respondents who had a high-risk perception were 612(28.0%). Whereas, among those who exhibited a positive attitude, the respondents who perceived higher risk were more than 623(28.6%) compared to those who had a lower risk perception of 222(10.2%).

Table 4: Relationship between Risk Perceptions and KAP.

Variable	Category	Low risk	High risk	$\chi2$	df	P-value
Knowledge	Poor	574(26.5%)	144(6.6%)	590.194	1	0.001
	Good	369(16.9%)	1091(50.0%)			

Attitude	Negative	725(33.2%)	612(28.0%)	164.704	1	0.001
	Positive	222(10.2%)	623(28.6%)			
Practices	Unsafe	913(41.8%)	1182(54.2%)	0.688	1	0.237
	Safe	34(1.6%)	53(2.4%)			

VIII. DISCUSSION

There has been an increasing public concern about the extent of the threat of environmental pollution from household pharmaceutical product handling, especially in developing countries (Ahmed et al. 2007; Ariffin and Zakili 2019; Barnett-Itzhaki et al. 2016; Jonathan P. Bound et al. 2006; Dias-Ferreira, Valente, and Vaz 2016). However, there appears to be very little knowledge regarding public risk perception on the environmental impacts of pharmaceuticals. The current study focuses on the risk perception of Abuja residents, in Nigeria. These results suggest an association between risk perception on the environmental impacts of pharmaceutical handling and KAP. The findings showed that socio-demographic factors, such as location, educational level, occupation, and medical history of the respondents, were consistent and significantly associated with risk perception in Abuja. The results were in agreement with the previous studies conducted in Ibadan, Nigeria (Oyeleke 2018), China (Wang et al. 2018) and in the South-East of England (Bound et al. 2006; Slovic 2007; Slovic, Fischhoff, and Lichtenstein 1982).

Furthermore, the observed association between knowledge, attitude, and risk perception suggests that knowledge and attitude influenced how the Abuja public perceived the risk of pharmaceutical handling in their environment. However, practices showed no significant association with the perceived risk. Previous studies in this area reported a relationship between knowledge, attitude, and risk perception (Beyer, Fasolo, and Graeff 2018; Low et al. 1996). However, a study by Dohle et al. reported a weak, but the statistically significant inverse relationship between the mean of risk activities score and mean of risk perception score throughout the whole domains, except for the social domain (Dohle, Campbell, and Arvai 2013).

The findings further revealed that among the six area councils, respondents from Bwari and Kwali significantly perceived high risk as opposed to the rest of the area councils in Abuja. These locations happened to be in the suburb of Abuja, which could explain why the respondents perceived higher risk than people within urban settings. A study conducted in Nigeria on the health risk awareness of electronic waste also reported a significant association between respondent's location and perception of riskiness (Ohajinwa et al. 2017). The previous study established a strong relationship between gender and risk perception (Beyer et al. 2018; Renn 1998; Slovic et al. 1982). In contrast, the current study found no statistically significant association between the variables. Probably because both males and females are risk-averse in terms of the environmental impacts of pharmaceuticals. The relationship between risk perception and the educational level of the respondents showed those with no or lower level of education perceived low risk than the respondents with higher education. Nigerian Certificate in Education (NCE) and bachelor showed higher risk perception except for those with postgraduate education, which showed relatively lower risk perception. Likewise, occupation-wise, those whose occupation was business and civil servants had a high-risk perception compared to others. Furthermore, there was a statistically significant relationship between respondents' income and risk perception. Respondents perceived risk with an increase in the unit of income. However, respondents' age and household size showed no statistically significant association.

In this study, a substantial proportion of the respondents showed good knowledge regarding the environmental impacts of pharmaceuticals, which indicated that the public is aware of the hazards associated with the unsafe practices of pharmaceutical handling. In contrast, despite their knowledge, most of the respondents were found to exhibit a negative attitude toward the risk of unsafe pharmaceutical handling practices. Perhaps because their perceived benefits of medication over the risk were higher. It is a well-known fact that there is a strong link between risk perception and benefit (Dohle et al. 2013; Slovic

et al. 2007). Unfortunately, both the benefit and risk are not only strongly connected but are within the 'affective heuristics' domain (which defines a positive or negative quality of stimulus). This 'affect heuristics' allows the public to balance between their health benefits and environmental considerations, which makes them make choices between health benefits and environmental consequences when making decisions about medication handling (Finucane et al. 2000). Therefore, in this study, attitude questions elicited a more negative response about pharmaceuticals in the environment. However, the affective domain was not measured directly in this study.

The results of the present study also suggest that the vast majority of the people demonstrated unsafe practices of pharmaceutical handling in the community, which has consequences for both human health and environmental well-being. The results showed that environmentally friendly options were not considered by the public and eventually released more pharmaceuticals into the environment. Unsafe practices such as household use, storage, and disposal methods have the potential risk of environmental loading of pharmaceuticals. Even though most countries made it a law for pharmaceutical companies to include in their medicine labels environmentally friendly instructions on how to handle pharmaceuticals (Akici, Aydin, and Kiroglu 2018; Auta et al. 2013; Barnett-Itzhaki et al. 2016; Daughton and Sue 2013; Doerr-MacEwen and Haight 2006; Wennmalm and Gunnarsson 2009).

Surprisingly, most of the respondents in this study were well-informed and more knowledgeable about the harmful environmental effects of pharmaceutical products. It is reasonable to propose that those knowledgeable people would have been more careful about how they handled pharmaceuticals. Since they are associated with adverse environmental consequences such as intersex, embryonic distortion, genetic distractions, cancer, and endocrine-disrupting ability (Ismail, Wee, and Aris 2017; Lim and Aris 2014; Wee and Aris 2017a), in some cases, death leads to population decline (Access 2017; Vellinga et al. 2014). Since our survey was a random sample of adults, the general findings drawn from this study are guaranteed; specifically, the environmental impacts of pharmaceuticals were not considered knowledge of the environmental consequences, possibly due to people's negative attitudes. However, in our future study, we will consider exploring the influence of socio-demographic factors, knowledge, attitude, and practices on risk perception. There are numerous advantages to the pragmatic study of risk perception among the general public. The study of risk perception provides an improved understanding of how KAP can influence public risk perception. The study also creates awareness of how risk perception impacts people's behaviors. Likewise, the study showed the relationship between risk perception and KAP and socio-demographic factors.

The study is not without some limitations. Firstly, due to financial and time constraints, only two districts in the Area councils of Abuja, Nigeria were chosen to conduct the survey. This limitation may influence the outcomes of the overall findings. Secondly, the cross-sectional study only gives periodic "snapshots" of participants' pharmaceutical handling-related data. Thirdly, even though the researchers told the respondents that confidentiality would be maintained, some respondents were careful and avoided choosing answers directed at their medical history, which might cause some levels of uncertainty in the results.

Notwithstanding, this is the first population-based study on pharmaceuticals in which data collection involved multiple districts spread across all the area councils in Abuja. We are confident that the study will help decision-makers develop effective risk policy frameworks and risk communication strategies to limit pharmaceutical pollution risks. Firstly, it can help decision-makers to picture the difference between the risk perceived by residents and the factors deriving the perceived risk, make reasonable risk regulations based on the characteristics of the residents, and shape the attitude caused by this risk perception deviation. For example, higher risk perception could likely result in social panic, while lower risk perceptions could lead to undesirable mitigation. Secondly, the study will make it convenient to detect which factors contribute to the perceived risk in Abuja, especially to pharmaceuticals in the environment. Therefore, understanding pharmaceutical risk perceptions is a panacea for better risk communication strategies for the public and, ultimately, for encouraging the safe

and effective handling of pharmaceuticals, especially in households. Households are among the significant contributors to the environmental loading of APIs due to improper handling, resulting in perpetual unabated human health risks and ecological consequences.

CONCLUSION

Generally, our results suggest that apart from KAP, risk perception is strongly related to socio-demographic factors such as geographic location, gender, age, income, educational level, and family size of an individual. The findings of this study also suggested that the environmental impacts of pharmaceuticals, as well as risk perception, are determined mainly by public attitudes and practices regarding pharmaceutical handling. Risk's subjective and perceptual nature makes it a significant field of research for psychologists. Probably the closest example that comes to mind of the subjective nature of risk is the divergence of world views of what the risk is between experts and laypersons. Again, the study suggested that future research could examine other aspects of the psychometric domains, such as cognitive and emotional domains, to unravel the reason behind people's choices of pharmaceutical handling practices leveraging the benefits of pharmaceuticals rather than the environmental well-being. Therefore, the study recommended that while a public education campaign on the risks associated with pharmaceuticals is not constructive, awareness of attitudinal change is imperative through community pharmacists, doctors, and health professionals with the help of media to save the environment. The legislation of regulatory frameworks that will discourage unwholesome behaviors and practices capable of discharging pharmaceuticals into the environment should be in place to prevent and control pharmaceutical pollution from point sources. Thus, this will help to reduce the environmental impacts of pharmaceuticals.

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