Research Article

Knowledge of Risk Associated with Exposure to Per- and Polyfluoroalkyl Substances in Abuja, Nigeria

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Per- and Polyfluoroalkyl Substances (PFAS) are a group of chemical compounds that contain mostly carbon and fluorine in their structure. They do not occur freely in nature but are produced industrially. Recent Studies have shown that PFAS exposure to the environment is persistent, bioaccumulative and poisonous to all life forms. Also, reports indicate that some of these products are being phased out in America and Europe but some of them still find their way to African markets and other parts of the world. The challenge is that a great number of people in Abuja, the study area do not know what PFAS is and the risk associated with the use of products that contain PFAS. Therefore the study is to ascertain the knowledge of PFAS in Abuja and highlight some of the risks of exposure. A self-designed questionnaire was used to obtain data using a random sampling technique. A total of 365 questionnaires were used for the study. The result revealed that 91% of the sampled population knew nothing about PFAS and its associated health risk while 9% knew PFAS and its associated health risk. This may point to the fact that PFAS exposure in Abuja may not pose only a localized risk but may progress to be a global risk. Therefore this paper recommends massive study and awareness programmes on PFAS and also appeals for the support and collaboration of industrialized nations towards programmes that will ensure sustainability.

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Introduction

Per- and Polyfluoroalky Substances (PFAS) are a group of chemical compounds that contain mostly carbon and fluorine in their structure. The release of PFAS, a fluoro-organic chain chemical compound into the biosphere, occurs through human anthropogenic activities of production, use and waste generation (liu and Avendano, 2013). PFAS are a large group of chemicals which may be toxic to humans, especially PerfluorooctaneSulfonate (PFOS) and Perfluorooctanoic Acid (PFOA). The two are widely used and easily contaminate the environment with the potential of depositing in the food chain (Betts, 2007). A lot of studies have been carried out on PFOS and PFOA and are found to be persistent in the ecosystem and also unsusceptible to normal environmental deterioration processes (USEPA 2017, OECD 2002). They are not found naturally in the earth's surface but are man-made compounds (ATSDR 2021, USEPA 2009b).

PFOS and PFOA being organic molecules, highly fluorinated, are known to have the highest volume of production in the United States of America (ATSDR 2021; EFSA 2008). They are very stable chemical compounds comprising chains of eight carbon atoms with a distinctive ability to block oil and water, therefore they are used in the production of a wide range of household and industrial products that are very durable (ATSDR, 2021). Some of these products include nonstick cookware, industrial surfactants, chemical and fire-resistant plumbing tubes, waterproof clothing materials, firm cardboard packaging, leather materials and carpets.

Due to the wide application of PFOS and PFOA, there is dissemination along various levels of the food chain, contaminating also the air, soil, surface and groundwater (USEPA, 2017). The presence of PFOS and PFOA in organisms high up the trophic level is a strong indication of the potentiality for bio-accumulation/bio-concentration (USEPA, 2017). Studies have linked PFAS to various types of cancer; endocrine damage, reproductive system defects, and is potentially toxic to animals (UNEP, 2006; Betts, 2007). There is suggestive evidence by USEPA that PFOS and PFOA may cause cancer (USEPA 2016d; 2016e). The Presence of PFOS and PFOA in the blood samples of studies in humans and wildlife is an indication that exposure to these chemical substances can be prevalent (ATSDR 2021; USEPA 2015).

Summarizing the effects of PFAS in Heartland community engagement, animal exposure can damage the liver, endocrine system, immune system, and neurological systems while in humans the exposure can affect the general well-being, damaging the reproductive systems, musculoskeletal systems, blood vessels and also reducing the potency of some drugs and vaccines(Mills, 2018). The sources of exposure include ingestion of food or water contaminated with the chemicals, use of consumer products

containing PFAS and inhalation of PFAS-containing particulate matter in the air (ATSDR 2021; USEPA 2009b). Furthermore, exposure can be through goods imported from countries where PFOS and PFOA are still in use (USEPA 2016b, 2016f). Reports are indicating that some of these products are being phased out in America and Europe but some of them still find their way into African markets and other parts of the world.

In the previous studies concerning PFAS, Morales-McDevitt et al. (2021), found the substances in different levels of concentrations in the air and surface water of Dhaka, Bangladesh. In addition, the studies of PFAS in aquatic environments in some parts of the world conducted by (Munoz et al. 2022; Macorps et al. 2022; Miranda et al. 2020; Miranda et al. 2021), show that PFAS were found in various degrees of concentrations in all the biota collected and analyzed. It was also found in surface water, deep water and sediments (Miranda et al. 2021). Most of these previous studies are centred on the presence of PFAS in the air and bioaccumulation in aquatic organisms and their environment.

No studies have shown the public perception or knowledge of PFAS. Knowledge of PFAS studies has not been carried out in Abuja and this informed the study. PFAS is very ubiquitous and a potential toxin. Abuja city experiences a daily increase in population due to rural-urban migration and with increased uses of products containing PFAS such as nonstick cookware, various types of fire-resistant housing materials and textiles. The waste and old materials of these products end up in municipal dumps, openly incinerated with resultant pollution of the environment. Therefore, this study aims to ascertain the knowledge of PFAS in Abuja and highlight some of the risks of exposure.

Materials and Methods

In this study, a total of 365 questionnaires were used and a random sampling technique using a self-designed questionnaire method was used to obtain the data; the survey was carried out between January and May 2022 at the following locations; Eagle Square, Wuse Market, Utako Market and New Garki Market. These locations fall within the developed phases 1 and 2 of Abuja (FCT).

Study areas

The study areas were Eagle Square, Wuse Market, Utako Market and New Garki Market in Abuja (Federal Capital Territory (FCT) which is in the north-central region of Nigeria, a tropical Sudan savannah with approximate coordinates of, latitudes 8°21′ and 9° 18′ N, longitudes 6° 46′ and 7° 37′ E(Etuk et al. 2022) as shown in Fig. 1 below. Abuja which is the Federal Capital Territory (FCT) of Nigeria experiences a daily

influx of visitors from all over the world, ranging from heads of government, diplomats, top businessmen, chief executives of multi-national companies and tourists.

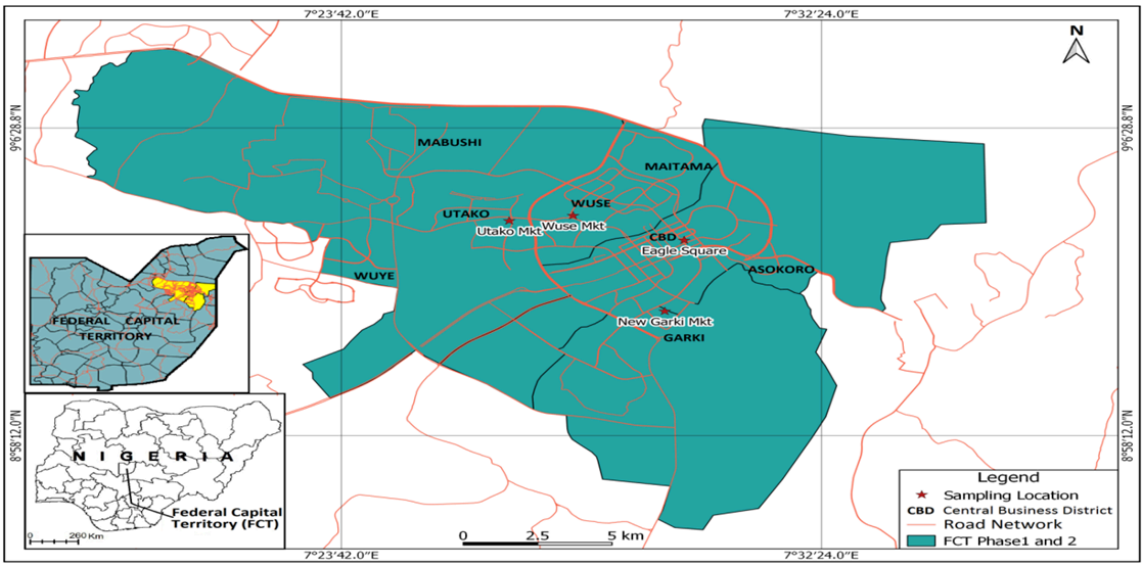

Fig. 1. Abuja (Federal Capital Territory) showing the sampling locations

Statistical analysis

A total of 365 questionnaires were used in this study and all the data collected were analyzed using percentages (Akpomi, 2010).

Results

The Results generated from the completed questionnaires which concentrated on the following items, namely; age group (years), educational and vocational levels and marital status are shown in Tables 1, 2 and figures 2 - 5 below.

STATUS	MALE		FEMALE		TOTAL	
	NO.	% OF 365	NO.	% OF 365	NO.	% OF 365
Age Group (Years)						
18-29	62	16.9	75	20.6	137	37.6
30-39	36	9.9	61	16.7	98	26.8
40-49	35	9.6	53	14.5	87	23.8
50 and above	25	6.9	18	4.9	43	11.8
∑	**158**	**43.3**	**207**	**56.7**	**365**	**100**
EDUCATIONAL						
Tertiary	31	8.5	68	18.6	99	27.1
Secondary	66	18.1	73	20.0	139	38.1
Primary	47	12.9	45	12.3	92	25.2
Informal	14	3.8	21	5.8	35	9.6
∑	**158**	**43.3**	**207**	**56.7**	**365**	**100**
VOCATION						
Public Servants	36	9.9	51	14.0	87	23.9
Self Employed	49	13.4	33	9.0	82	22.4
Students	54	14.8	69	18.9	123	33.7
Unemployed	19	5.2	54	14.8	73	20.0
∑	**158**	**43.3**	**207**	**56.7**	**365**	**100**
MARITAL						
Married	65	17.8	68	18.6	133	36.4

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STATUS	MALE		FEMALE		TOTAL	
	NO.	% OF 365	NO.	% OF 365	NO.	% OF 365
Single	53	14.5	73	20.0	126	34.5
Divorced	11	3.0	27	7.4	38	10.4
Widowed	29	8.0	39	10.7	68	18.7
∑	**158**	**43.3**	**207**	**56.7**	**365**	**100**

Table 1. Socio-economic status of respondent

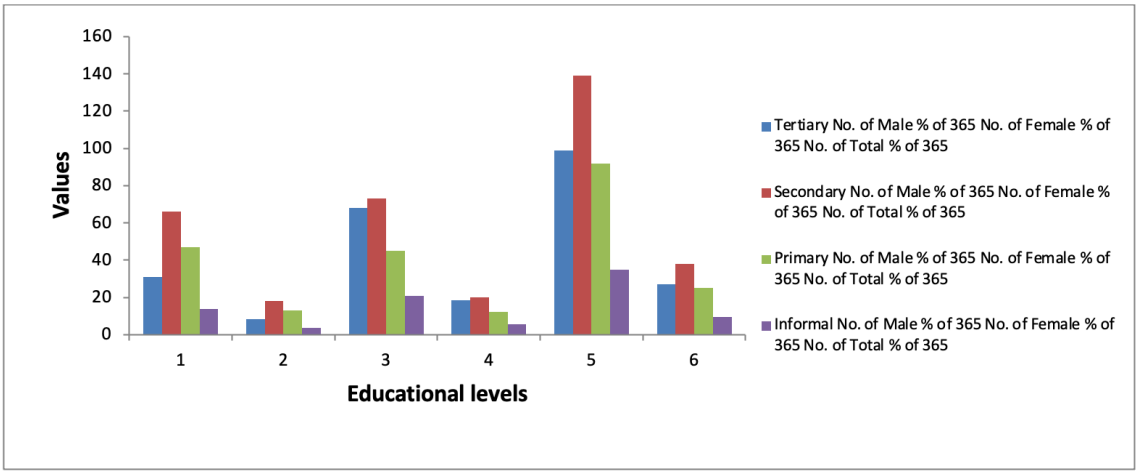

Fig. 2. Educational Levels of the Assessed Candidates

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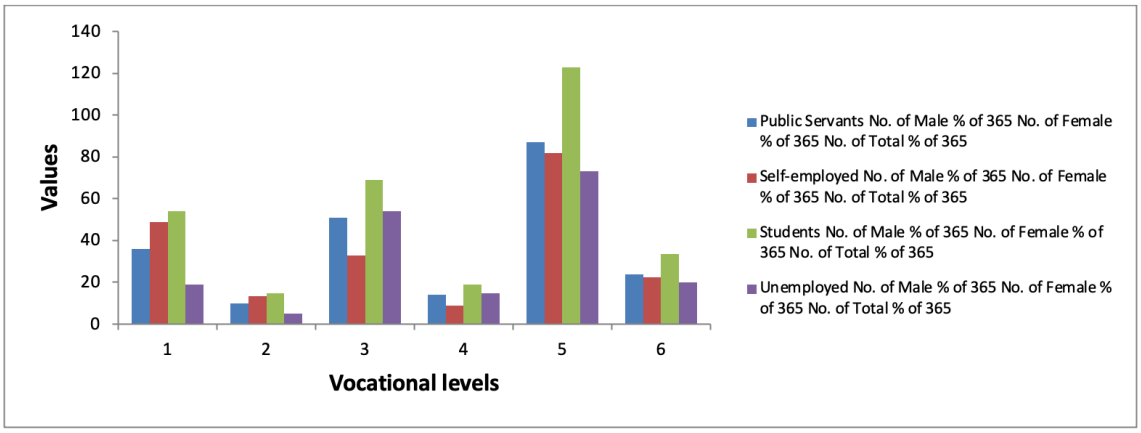

Fig. 3. Vocational Levels of the Assessed Candidates

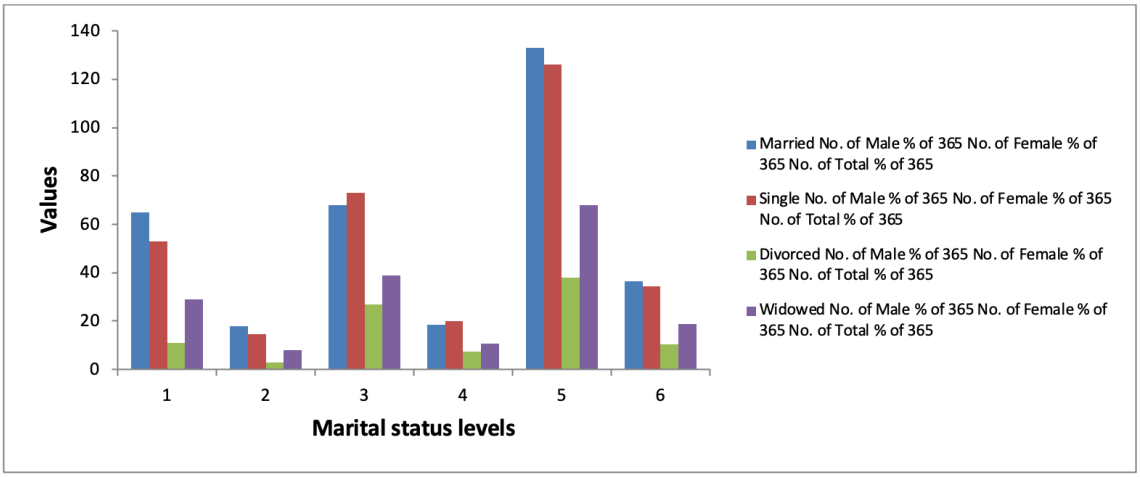

Fig. 4. Marital Status Levels of the Assessed Candidates

The results generated from the responses from the completed questionnaires are shown in Table 2 below.

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S/N	QUESTION	Affirmative		Non-Affirmative	
		No.	%	No.	%
1.	Have knowledge of PFAS and associated risks	33	9.0	332	91.0
2.	Have used products containing PFAS	338	92.6	27	7.4
3.	Checking of products components to ensure PFAS free	0	0.0	365	100
4.	Discussed or attended discussion on the risk of PFAS exposure	0	0.0	365	100
5.	Government adequately informs the populace on health and safety issues	25	6.8	340	93.2
6.	Government to be blamed on the indiscriminate use of PFAS containing products	298	81.6	67	18.4
7.	Willing to attend awareness program or enlightenment on PFAS and associated risks	312	85.5	53	14.5

Table 2. Response from completed questionnaires (n=365)

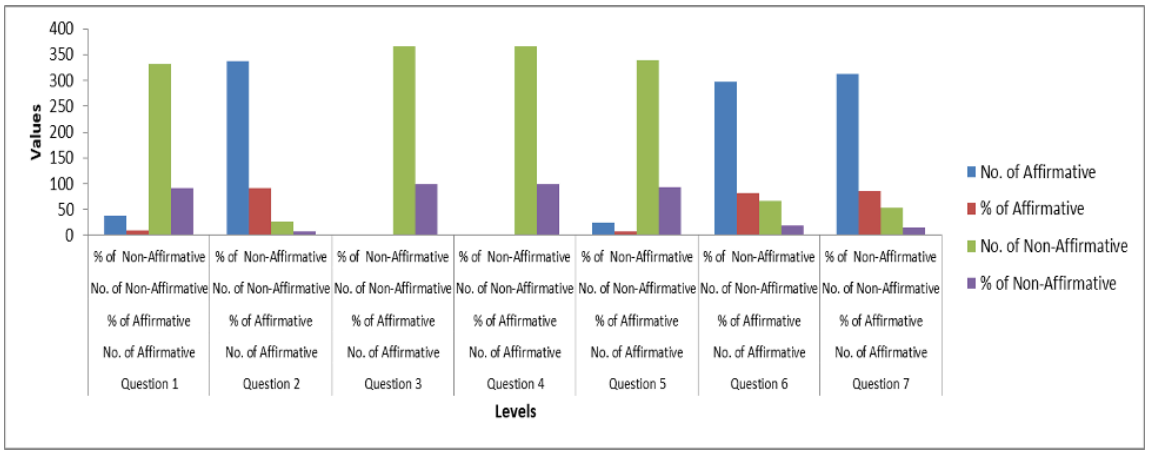

Fig. 5. Responses Levels of the Assessed Candidates

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Discussion

From Tables 1-2 and Figures 2-5, the result shows that 91% of the sampled population knew nothing about PFAS and its associated health and environmental risks. This may be a result of ignorance or lack of information, then 92.6% of respondents have used products containing PFAS, which indicates the easy availability of such products in the study area and with the very low level of awareness, 100% of the respondents do not check the active ingredients or compositions of consumer product before use. Furthermore, 100% of the respondents have not discussed or attended any public discussion on the risk of PFAS exposure and 93.2% blame the government for the indiscriminate use of PFAS-containing products. In addition, 85.5% of the respondents were willing to attend an awareness program or enlightenment on PFAS and associated risks. Since no studies have shown the public perception or knowledge of PFAS, there is no basis of comparison as regards this study.

It was observed that:

i. Most of these products containing PFAS are imported from America, Europe and Asia.
ii. Nothing is being said or done by the government, agencies or NGOs in Nigeria.
iii. It is in general belief in Nigeria, that anything imported is good and authentic.

This may point to the fact that PFAS exposure in Abuja, and other parts of Nigeria and Africa may not pose only localized risk but may progress to be a global risk or problem. They are very stable and have the potential for long-range atmospheric movement (ATSDR, 2021). It is very important to note that there are insufficient resources and capacity to study, monitor or track the incidence of PFAS in Abuja and any other city in Africa (Ssebugere et al. 2020).

Recommendations

The following recommendations were suggested, namely:

i. This paper recommends a massive study and awareness programme on PFAS and also appeals for the support and collaboration of industrialized nations towards initiatives that will ensure sustainability.
ii. The major challenge we have in Africa is funding, therefore we call on the agencies or groups that fund studies and projects on PFAS in America and Europe to extend such funding to Africa.

iii. Research agencies and groups working in America and Europe on PFAS should make readily available their research findings to individuals and groups in Africa.

iv. United Nations Environment Programme (UNEP), and Stockholm Convention on Persistent Organic Pollutants (POPs) offices should monitor effectively the movement of PFAS chemicals and products across Africa and apply sanctions as required.

v. On the local scene, the Nigerian government through the relevant agencies should not allow the importation of PFAS chemicals and products. In addition, they should embark on studies and awareness programmes at all levels (local, state, regional, and national).

In addition, we call on researchers and research institutes all over the world, as a matter of urgency to look for alternative chemicals in place of PFAS. Also, governments and organizations across the globe should support the research by providing adequate funding. Finally, we recommend further research on the concentration of PFAS in the blood and body tissues of the residents of Abuja and other major cities in Nigeria.

Statements and Declarations

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Conflict of interest

The authors have no conflict of interest to declare that are relevant to the content of this article.

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Declarations

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