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Spatio-Temporal Trend of Water Related Diseases Incidence Across Campuses of Government Owned Tertiary Institutions in Port Harcourt, Rivers State, Nigeria

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Abstract: The prevalence of water related sicknesses occurrence observed among students of Government owned tertiary institutions in Port Harcourt, Rivers State necessitated this study. The quasi- experimental research design was used and data relating to water related sicknesses were obtained from the archives of the health centres in the various institutions were. Water samples from the different sources of drinking water in the campuses investigated were collected and analyzed using standard laboratory techniques. The results revealed that there was a statistically significant variation in incidence of water related sicknesses at the various campuses spatially (TF- F= 12.071, p = 0.000; DL- F= 12.008, p = 0.000; DY- F= 9.017, p = 0.000; SR- F= 5.388, p = 0.004; AD- F= 3.037, p = 0.041) and on temporal basis (2018- F= 50.444, p = 0.000; 2019- F= 20.533, p = 0.000; 2020- F= 7.215, p = 0.001; 2021- F= 7.515, p = 0.001; 2022- F= 17.613., p = 0.000). The microbial content of the water samples revealed the presence of total coliforms, faecal coliforms and E. Coli showing that the water consumed on the campuses is not potable. It is evident that the status of available sources of water consumed has a significant correlation with the reported cases of water related illnesses amongst members of the university community. The recommendations made includes, immediate declaration of state of emergency on the water sources on the campuses, formation of an effective and sustainable water quality monitoring and assessment committee, encouragement of high level of personal hygiene among students, enforcement of University wide sanitation taskforce, and routine check and maintenance of septic tanks to watch out for possible leakages.

Keywords: Prevalence, Waterborne Diseases, Incidence, Spatio-Temporal, Trend

1. Introduction

Water is a fundamental component of life on the planet Earth and of course the most copious and indispensable resources of man, and occupies about 70%. Its chemical formula is H_2O implying that each of its molecules contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is considered to be more basic than all other critical stuff to life and a prerequisite for important physiological and biochemical processes and commended key to health [14, 20]. Groundwater such as borehole is widely used in Nigeria as major source of water consumption. Unfortunately borehole water like water from other sources is to a greater extent not completely pure as the purity level varies from place to place and from location to location depending on many factors including the geological conditions of the soil through which the ground water flows and some anthropogenic activities. In 2015, World Health Organization (WHO) reported that unsafe drinking water causes a lot of health issues and millions have suffered all manner of water borne diseases, with common being diarrhoea which has caused millions of deaths yearly,

especially in developing countries. On the other hand, a number of health cases such as typhoid, diarrhoea, dysentery and cholera identified to be related to consumption of contaminated water have been found to be prevalent amongst the students in higher institutions and the diversity of their occurrences vary from one campus to another depending on factors such as the environmental hygiene, level of literacy, economy, technological advancement, medicare services, drugs availability and, of course, the population density of the place [16]. It is also asserted from medical findings that issues of public health anchors on two major drivers which include existence of the disease-causing pathogens and the exposure possibility of individuals [8]. By WHO rating, Africa as a whole still falls below the expected good health standard when compared to its western counterparts and Nigeria is no exception [16]. This is primarily due to low living standard, high rate of poverty and population growth. Such conditions are very much prevalent within the university communities of most states of our country. The campuses of most Nigerian higher institutions are practically over populated with regards to the available number of hostel accommodations and staff housing quarters [5, 26].

The hostels in most of the campuses host a student population statistic of about 5 persons to a room of 12×12 feet or more. With pressure on intakes, the unapproved hostel residency called 'squatting' is almost gaining an official recognition among students in all hostels. This is excluding the greater part of the student population living at various congested private hostels within the host and neighbouring communities. The congestion of people, to start with, makes the exposure rate high within such environment and hosts a likelihood of low hygiene level and behaviour [5]. According to [30], the principal water related diseases common within the environments of the university settings are malaria, diarrhoea, cholera, dysentery, warm infections, skin rashes while cases such as diarrheal diseases are strongly based on ingestion of either contaminated food and or water substances – a medium through which the pathogen travels whereas cholera, guinea worm, typhoid and dysentery are mainly known to be contacted through exposure to contaminated water bodies [(23, 10]. This is quite disturbing as it clearly shows that there is complete or near absent of potable water sources on the campuses. It is against this background that the study was necessitated to identify the sources of water supply within the different campuses, the water related diseases prevalent among students in the various higher institutions as well as the spatial spread across the study area.

2. Material and Methods

The study area is in Rivers State which lies at the south-south base of the Niger Delta region of Nigeria, within the geographic range of latitude 4^0 45' North and longitude 6^0 50' (WGS 84) East of the Greenwich Meridian, Nigeria. The city is the oil business hub of Nigeria and closely bordered to its western flank by Yenegoa and Warri towns; having Umuahia town at the east, Owerri town towards it north and Uyo lying in its south-eastern border. Its location, therefore, makes the region a very busy business district with high influx of people to and from it neighbouring towns. This becomes a factor that has encouraged the residency of people within the communities that make up Port Harcourt metropolis. The area is one of the sizeable metropolitan areas in Nigeria with a total population estimate of 6,000,000 based on the 2006 National Population Commission report (NPC, 2012). The data for this study was obtained from each of the institutions health facility that was visited which includes University of Port Harcourt, Rivers State University, Captain Elechi Amadi Polytechnic, Rivers State College of Health Sciences and Management Technology and Ignatius Ajuru University of Education. These institutions were purposively selected for this study as Government owned tertiary institutions and the incidences of water related diseases such as typhoid, diarrhoea, dysentery, skin rashes and abdominal disorder were obtained from the archives of the health centres of the various institutions. Also, water samples from the identified sources of water supply at the various campuses were collected in 250-ml borosilicate glass bottles sterilized at 121°C for 15 minutes and then transported to the laboratory at the Department of Water Affairs in Maun in cooler boxes with ice. The water samples were analyzed for total coliforms, fecal coliforms and *E. Coli* at the laboratory using membrane filter technique following the description by [4]. Aliquots of the water samples (100 ml) were filtered through sterile 0.45-µm membrane filter papers which were incubated in agar plates at 37°C for coliforms and incubated at 35°C for *E. coli* while Oxoid CM 1031 Membrane Lactose Glucoronide Agar (MLGA) was used for their identification and enumeration respectively. The data for this study were analyzed using ANOVA and trend analysis statistics.

Table 1. *Incidences of Water related Diseases at the various Campuses.*

	Years	Typhoid Fever (TF)	Diarrheal (DL)	Dysentery (DY)	Skin Rashes (SR)	Abdominal Disorder (AD)	T	%
	2018	245	214	271	144	259	1,133	37.17
	2019	215	187	198	215	235	1,050	34.45
	2020	142	69	66	117	32	426	13.98
RSU	2021	159	61	69	22	57	368	12.07
	2022	29	5	11	10	16	71	2.33
	Total	790	536	615	508	599	3,048	100
	Percentage (%)	25.92	17.58	20.18	16.67	19.65	100	
UNIPORT	2018	326	241	283	301	300	1,451	28

	Years	Typhoid Fever (TF)	Diarrheal (DL)	Dysentery (DY)	Skin Rashes (SR)	Abdominal Disorder (AD)	T	%
	2019	340	196	181	200	196	1,113	21.48
	2020	312	216	200	162	100	990	19.10
	2021	210	197	192	90	126	815	15.73
	2022	172	221	206	102	112	813	15.69
	Total	1,360	1,071	1,062	855	834	5182	100.0
	Percentage (%)	26.24	20.67	20.49	16.50	16.10	100	
IAUE	2018	65	78	40	76	55	314	18.81
	2019	104	65	50	38	76	333	19.95
	2020	120	62	55	48	77	362	21.69
	2021	96	56	45	60	88	345	20.67
	2022	102	75	67	54	17	315	18.87
	Total	487	336	257	276	313	1,669	100
	Percentage (%)	29.18	20.13	15.40	16.54	18.75	100	
CEAP	2018	0	0	1	0	6	7	1.49
	2019	3	2	1	0	9	15	3.21
	2020	65	19	12	11	18	125	26.71
	2021	46	49	86	11	21	213	45.51
	2022	19	31	8	11	39	108	23.08
	Total	133	101	108	33	93	468	100
	Percentage (%)	28.42	21.58	23.07	7.05	19.87	100.0	
RCHSMT	2018	201	217	106	155	250	929	32.53
	2019	187	215	98	36	99	635	22.23
	2020	130	210	47	50	78	515	18.03
	2021	98	89	67	58	77	389	13.62
	2022	78	118	38	65	89	388	13.59
	Total	694	849	356	364	593	2,856	100
	Percentage (%)	24.30	29.73	12.46	12.75	20.76	100	

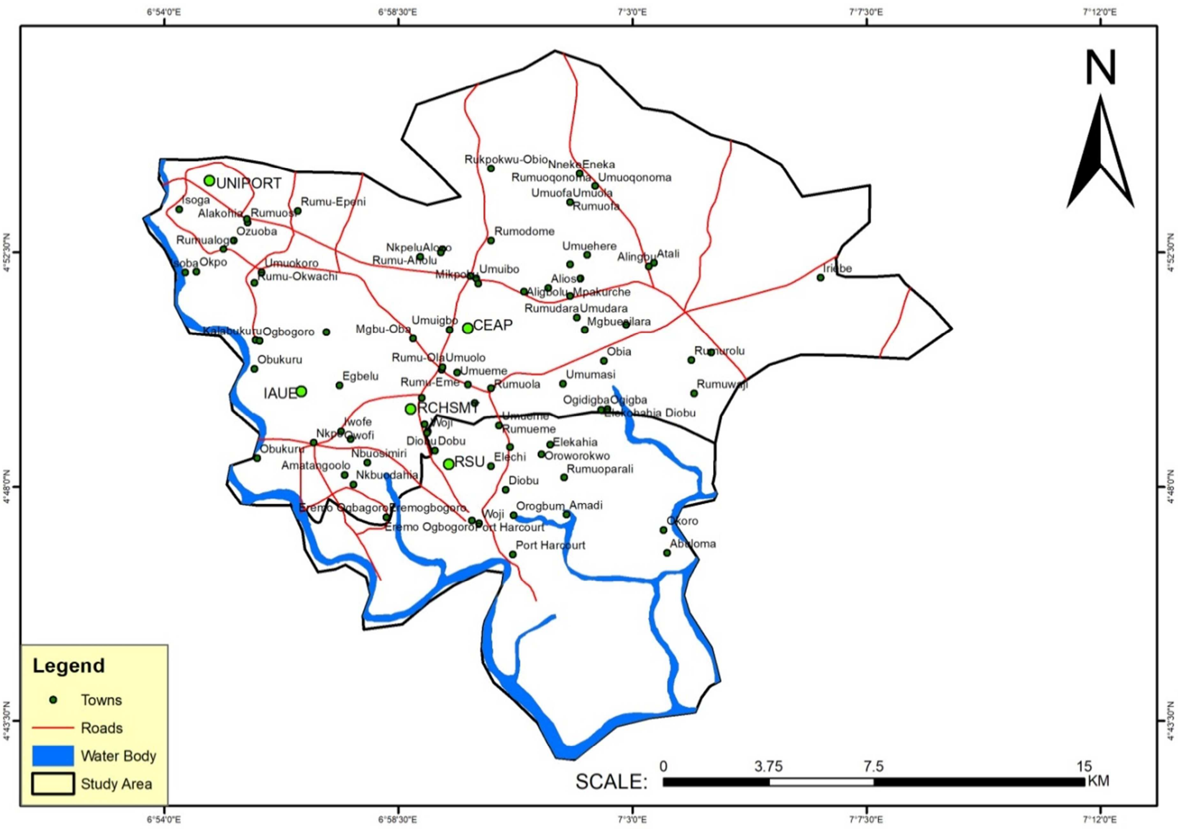

***Figure 1.** Sampled Tertiary Institutions.*

The water related diseases obtained from the medical centres of each of the institutions is reported in Table 1 and from the records five (5) different diseases, namely: Typhoid Fever (TF), Diarrheal (DL), Dysentery (DY), Skin Rashes (SR) and Abdominal Disorder (AD) are evidently shown. The incidence rate was highest in the year 2018 for Rivers State University (RSU), with 37% of the reported cases of water related diseases in the school medical centre. In 2019,

there was a decline in incidence rate as the record shows 34.45% of water related diseases and further drastic decline observed in subsequent years whereas 2020 recorded 13.8%, 2021 and 2022 had 12.07% and 2.33% respectively. In more specific terms, typhoid fever was highest indicating 25.92% of the total water related diseases cases reported, dysentery (20.18%), abdominal disorder cases (19.65%), diarrheal (17.58%) while skin rashes was the least with 16.67%. The table equally displays the data of the subject of investigation obtained from the University of Port Harcourt (UNIPORT). The record reveals that the reported cases of water related diseases were highest in the year 2018 with 28%. A steady decline in the incidence rate is also observed in subsequent years 2019 (21.48%), 2020 (19.10%), 2021 (15.73%) and 2022 (15.69%) reported respectively. Similarly, typhoid fever is also seen the most prevalent water related diseases experienced among students in UNIPORT as it records (26.24%) whereas others like Diarrheal reportedly recorded 20.67%, Dysentery had 20.49% of the reported cases while skin rashes recorded 16.50% abdominal disorder standing at 16.10% was the least among the cases reported. The record provided in Table 1 unravels a different pattern in the reported cases of water related diseases at Ignatius Ajuru University of Education (IAUE), other than a decrease in the incidence rate as the year progresses previously observed in RSU and UNIPORT, an increase in the incidence rate is consistently noticed within the first three (3) years and later a drop with 2018 and 2022 showing the least reported cases of 18.81% and 18.87% respectively. Again, typhoid fever is still recorded as the highest among the reported cases and 29.18%, diarrheal disease recorded 20.13% and skin rashes with 15.40% incidence rate was the lowest. Other water related diseases found the IAUE campus was dysentery and abdominal disorder which stood at 18.75% 16.54% and respectively. At the Captain Elechi Amadi Polytechnic (CEAP), the reported cases of water related diseases were moderate compared to the outcomes of the other sampled higher institutions sampled. As presented in Table 1, the year 2018 had only 1.49% of the total reported cases of water related diseases and remained the least in all the years across the sampled institutions while the year 2021 with 45.51% of the cases presented at the medical unit is the highest amongst other years. The trajectory observed in other campuses is not different at CEAP as typhoid fever stands out as the most prevalent water related diseases among students with an incidence rate of 28.42%, the second highest water related diseases reported at CEAP is dysentery with 23.07% while skin rashes was 7.05% as the lowest. Nevertheless, abdominal disorder and diarrheal diseases were also among the list of water related diseases documented in the archive of the medical unit of the institution and found to be 19.87% and 21.58% respectively. Also in Table 1 is the report of the incidence rate of water related disease for the Rivers State College of Health Science and Management Technology (RCHSMT) where it is noted that the year 2018 has the highest incidence standing at 32.53% and a decline in subsequent years similar to what happened in RSU and UNIPORT. In RCHSMT, the most reported case of water related disease is diarrheal with a documented evidence of 29.73% and followed by typhoid fever which recorded 24.30%. It is only in RCHSMT that diarrheal other than typhoid fever is observed as the most ubiquitous water related diseases while dysentery with an incidence value of 12.46% is the lowest. Abdominal disorder was found to be 20.76% while skin rashes were 12.75%. The abundance of water on the earth's surface is an unarguable fact. Nevertheless, about 90% of these water sources are not potable as they are majorly saline waters from the seas and oceans and with the drive of anthropogenic activities, most upland water ecosystems are disturbed by human encroachment into its channels and floodplains, especially within the urban centres of the world [27]. This modern-day advancement of man has resulted in the contamination of the few available sources of fresh water left for man and animal consumption with all manner of domestic and industrial pollutants [15]. The increase cases of water related diseases such as typhoid fever, dysentery, diarrheal, abdominal disorder and skin rashes observed on the campuses is traceable to the fact that there is not a single form of treated water system available in some of the schools as well as the presence of coliform in drinking water indicating that disease-causing organisms (pathogens) could be in the water system. Most of these pathogens that contaminate water supplies come from the faeces of humans or animals which are prevalent in most urban water sources without exception to these campuses.

Table 2 shows the spatial variation of Illnesses among the study locations. It is shown that typhoid fever, diarrheal, dysentery, skin rashes, and abdominal disorder significantly varied at $p<0.05$. Similarly, the temporal variation of illnesses from 2018 to 2022 in Table 3, it is shown that typhoid fever, diarrheal, dysentery, skin rashes, and abdominal disorder also varied significantly at $p<0.05$.

Table 2. *Spatial Variation of Illnesses across the Study Location from (2018-2022).*

		Sum of Squares	Df	Mean Square	F	Sig.
Typhoid Fever (TF)	Between Groups	162066.960	4	40516.740	12.071	0.000
	Within Groups	67131.200	20	3356.560		
	Total	229198.160	24			
Diarrheal (DL)	Between Groups	120869.040	4	30217.260	12.008	0.000
	Within Groups	50328.000	20	2516.400		
	Total	171197.040	24			
Dysentery (DY)	Between Groups	112087.440	4	28021.860	9.017	0.000
	Within Groups	62156.400	20	3107.820		

		Sum of Squares	Df	Mean Square	F	Sig.
	Total	174243.840	24			
	Between Groups	73958.160	4	18489.540	5.388	0.004
Skin Rashes (SR)	Within Groups	68626.000	20	3431.300		
	Total	142584.160	24			
	Between Groups	65939.840	4	16484.960	3.037	0.041
Abdominal Disorder (AD)	Within Groups	108547.200	20	5427.360		
	Total	174487.040	24			

Table 3. *Temporal Variation of Illnesses across the Study Location from (2018-2022).*

		Sum of Squares	Df	Mean Square	F	Sig.
	Between Groups	282172.960	4	70543.240	50.444	0.000
2018	Within Groups	27968.800	20	1398.440		
	Total	310141.760	24			
	Between Groups	175228.960	4	43807.240	20.533	0.000
2019	Within Groups	42670.400	20	2133.520		
	Total	217899.360	24			
	Between Groups	80825.040	4	20206.260	7.215	0.001
2020	Within Groups	56014.000	20	2800.700		
	Total	136839.040	24			
	Between Groups	41596.800	4	10399.200	7.515	0.001
2021	Within Groups	27675.200	20	1383.760		
	Total	69272.000	24			
	Between Groups	70567.600	4	17641.900	17.631	0.000
2022	Within Groups	20012.400	20	1000.620		
	Total	90580.000	24			

3. Trend Analysis of Diseases Across the Study Location

Table 1 shows the spatial variation of illnesses among the study locations. It is shown that typhoid fever, diarrhea, dysentery, skin rashes, and abdominal disorder was significantly varied at $p<0.05$. Similarly, the temporal variation of illnesses from 2018 to 2022 in Table 2, it is shown that typhoid fever, diarrhea, dysentery, skin rashes, and abdominal disorder was significantly varied at $p<0.05$.

Figure 2 shows that the trend analysis was reducing for all the diseases in RSU. Typhoid fever was reducing at the rate 48.8 per year with 85.92% of variation of the change. Diarrheal reduced at the rate of 54.4 per year with 93.02% variation of the change whereas dysentery reduced at the rate of 46.1 with 71.75% of variation. The rate of change of skin rashes from 2018 to 2022 was 64.9 with 91.09% variation and abdominal disorder reduced at the rate 66.4.

In UNIPORT as shown in Figure 3 that the diseases reduced from 2018 to 2022 with skin rashes having the highest rate of reduction (50.8), followed by abdominal disorder (44.6) and typhoid fever (45.8).

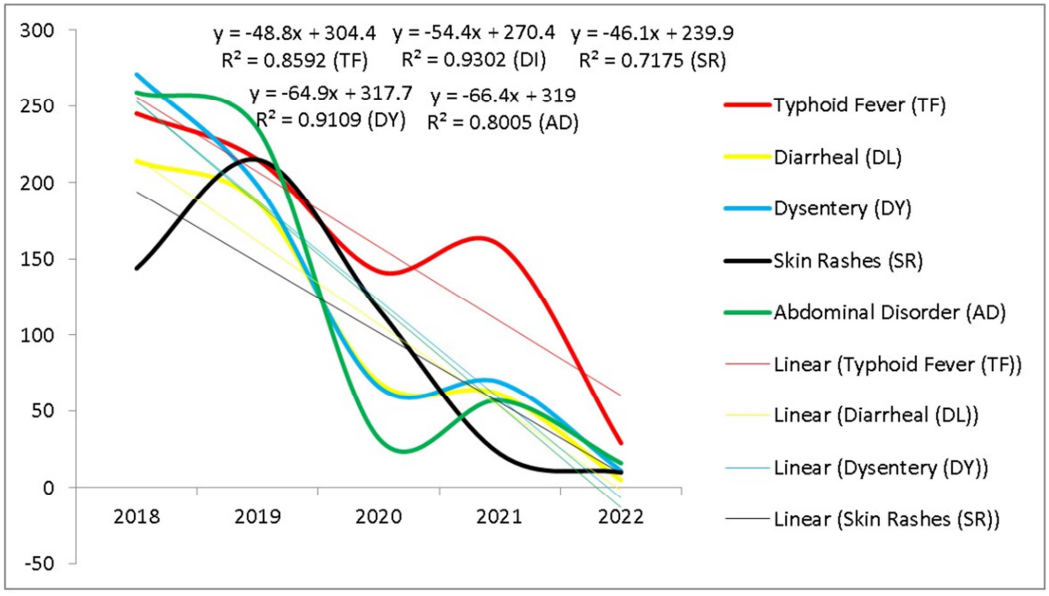

Figure 2. *Trend Analysis of Diseases in RSU between 2018 and 2022.*

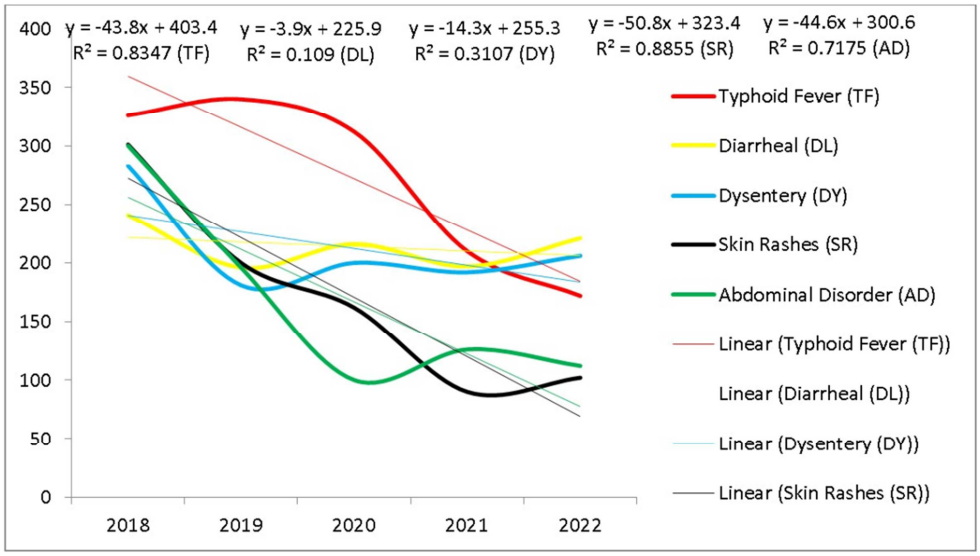

Figure 3. *Trend Analysis of Diseases in UNIPORT between 2018 and 2022.*

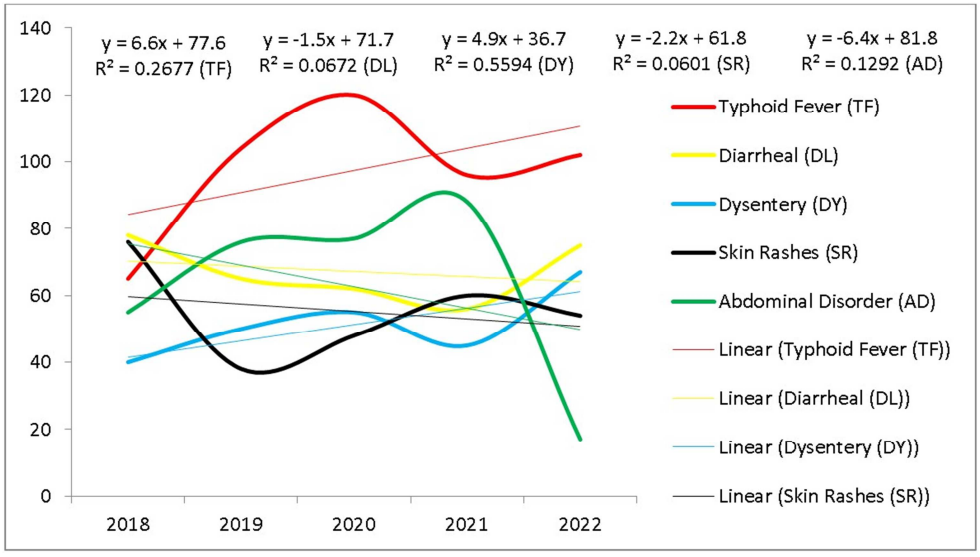

Figure 4. *Trend Analysis of Diseases in IAUE between 2018 and 2022.*

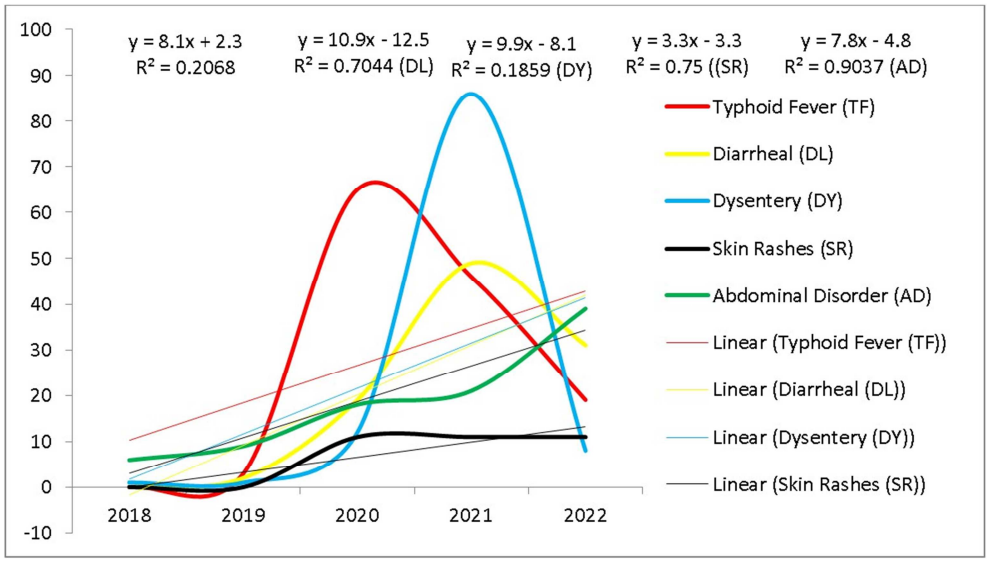

Figure 5. *Trend Analysis of Diseases in CEAP between 2018 and 2022.*

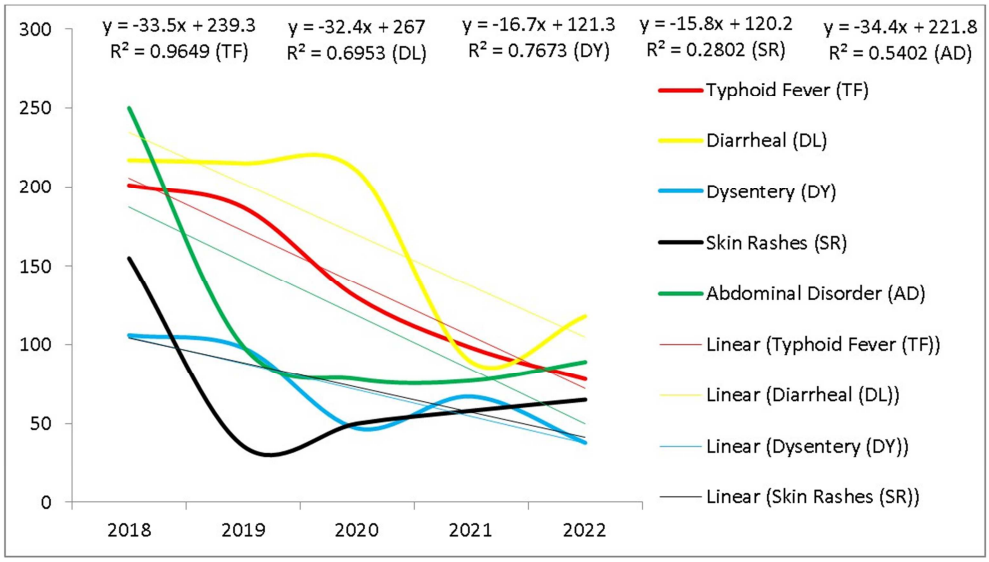

Figure 6. *Trend Analysis of Diseases in RCHSMT between 2018 and 2022.*

Table 4. *Sources of Water/ Biological Properties of Water Samples from the Institutions.*

Locations	Sources of Water				Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)	*E. coli* (MPN/100ml)	Potable Status
	Borehole	Rain	Surface Water	Packaged Water				
RSUST	Yes	Yes	Nil	Yes	<2	<2	<2	Not potable
UNIPORT	Yes	Yes	Nil	Yes	<2	<1	<2	Not potable
CEAP	Yes	Yes	Nil	Yes	<2	<2	<2	Not potable
IAUE	Yes	Yes	Yes	Yes	<2	<1	<1	Not potable
RCHSMT	Yes	Yes	Nil	Yes	<1	3	<2	Not potable

In IAUE as shown in Figure 4, it is indicated that typhoid fever was increasing at the rate of 6.6. Similarly, dysentery illness also increased at the rate of 4.9. However, diarrhea, skin rashes and abdominal disorder reduced at the rate of 1.5, 2.2 and 6.4 respectively. Furthermore, in CEAP, it is found that all the diseases increased from 2018 to 2022 at the rate of 8.1 for typhoid fever, 10.9 for diarrhea, 9.9 for dysentery, 3.3 for skin rashes and 7.8 for abdominal disorder. This is quite different from what was obtainable in RSU, UNIPORT and IAUE.

It is however revealed in RCHSMT that the disease reduced from 2018 to 2022 with the higher rates observed in abdominal disorder (34.4), typhoid fever (33.5) and diarrhea (33.5).

The result of the microbial content of water samples collected from the respective campuses under investigation is reported in Table 4 and the biological contaminants, in the water samples were observed to be above the recommended permissible limits of potable water specified by WHO. The drinking water samples collected the different institutions all showed presence of microbial content. Although, the UNIPORT samples showed negligible bacterial colony presence of faecal coliform at <1. Similarly, the IAUE drinking water samples showed negligible presence of *E. coli* at <1 MPN/100ml while active content of *E. coli* species were shown in samples from all other institutions whereas total coliform, faecal coliform and the *E. coli* recorded values which were all above the WHO recommended standard. Water requires a certain degree of quality to guarantee the suitability for the anticipated use particularly for consumption, or other domestic use to address the bacteriological, and trace organics, including other emerging contaminants as they poses health risk to water consumers when their presence is confirmed [13, 22, 7]. According to [18], most of these contaminants deteriorate water quality and render water resources unsafe for human consumption as health challenges such as endocrine disruption, thyroid function suppression, increased risk of developing diabetes, hormonal imbalance, and adverse neurobehavioral development are linked to consumption of such water [9, 28]. Meanwhile, the bacteriological assessment of domestic water is essential from a public health perspective to allow for necessary actions to be taken by the relevant authorities, and essentially, to prevent the outbreak of water-borne diseases such as cholera, diarrhoea, typhoid, and gastroenteritis [2, 6; 12, 28]. On the other hand, particularly in the opinion of [17] rainwater, ground and surface water are pinpointed as major sources of pollution of domestic water supply whereas rainwater is considered less polluted than water from surface and groundwater sources in most parts of the country. This postulation is very critical for the general public especially to cautiously choose the type of water they consume as the government is not taking absolute responsibility of providing the populace with treated water [21]. One fundamental problem, apart from the economic and environmental challenges which the university community faces as it continually carry out its core mandate of producing and developing human resources for nation building is the demise

of individuals within these ivory towers of learning due to several unexplained causes, and sometimes speculated on natural occurrence and diabolic impact [1, 3]. It is also evident by empirical notes that there are continuous admittances of students and workers on emergences of ill health at the various campuses which is a sign of degenerating health standards within the institutions [24, 19, 25, 11] and with increasing cases of water related sicknesses like typhoid, diarrhoea, dysentery among students due to several factors such as the environmental hygiene, level of literacy, economy, technological advancement, medicare services, drugs availability and, of course, the population density of the place [16]. It is possible to conclude based on the findings of this study that some of the reported death cases within the University community are health related particularly in connection with water related diseases since the sources of water supply in the campuses are either surface or groundwater which has already been identified as highly polluted and coupled with the fact that pressure on intakes has given room for the informal hostel residency called 'squatting' to gain an acceptable recognition among students in all hostels. Thus, leading to congestion and low hygiene level and behaviour and prevalence of water related diseases such as diarrhoea, cholera, dysentery, skin rashes among residents of the University community [5, 30]. Most water-related diseases especially diarrhoea has serious negative health impact on people. It is caused by gastrointestinal infections and causes 4% of all deaths and 5% of health loss to disability and responsible for death of around 2.2 million people globally each year [29]. It primary channel of transmission from one human to another remains contaminated water and food paths diarrhoea is a symptom of infection caused by a host of bacterial, viral and parasitic organisms most of which can be spread by contaminated water. It is more common when there is a shortage of clean water for drinking, cooking and cleaning and absence of basic hygiene which are conditions obviously lacking in most campuses as the available water are most times contaminated with human faeces from municipal sewage, septic tanks and latrines and animal faeces as well containing micro organisms that can cause diarrheal.

4. Conclusion and Recommendations

It is evidently clear from the study that the University students draw their water mostly from borehole and rainwater sources which are exposed to different contaminants as a result of modern day technological advancement of man. Thus, students are starved of potable water and had no option but to consume water with high content of biologically infested pollutants leading to prevalence of water related diseases among students on campuses at the various institutions investigated. Arising from the forgoing, a state of emergency need to be declared on the sources of water supply on campuses for proper and holistic intervention geared towards provision of potable water for the academic community at large. Meanwhile, effective and sustainable water quality monitoring and assessment committee should be set up, encouragement and enforcement of high level of personal hygiene and environmental sanitation, adequate monitoring and maintenance of septic tanks to avoid possible leakage and seepage into underground water, provision of state of the art medicare centres in the institutions were recommended.

References

[1] Abdullahi, A. A., & Amzat, J. (2011). Knowledge of Hypertension among the Staff of University of Ibdan, Nigeria. *Journal of Public Health and Epidemiology*, (5): 204-209.

[2] Adesakin, T. A., Oyewale, A. T., Bayero, U., Mohammed, A. N., Aduwo, I. A., Ahmed, P. Z., Abubakar, N. D., & Barje, I. B. (2020). Assessment of bacteriological quality and physico-chemical parameters of domestic water sources in Samaru community, Zaria, Northwest Nigeria. *Heliyon.* 6 (8).

[3] Akoria, O. A. (2009). A 6-Month Review of Medical Admissions in a Nigerian Teaching Hospital. *Interntional Journal of Health Research*, 2 (2): 125-130.

[4] APHA (1998) Standard Methods for the Examination of Water and Wastewater. 20th Edition, American Public Health Association, American Water Works Association.

[5] Asikhia, O. A. (2010). Students and Teachers' Perception of the Causes of Poor Academic Performance in Ogun State Secondary Schools [Nigeria]: Implications for Couselling for National Development. *European Journal of Social Sciences*, 13 (2): 229.

[6] Ayandiran, T. A., Fawole, O. O., & Dahunsi, S. O. (2018). Water quality assessment of bitumen polluted Oluwa River, South-Western Nigeria. *Water Resource Industry.* 13–24.

[7] Bamigboye, C. O., Amao, J. A., Ayodele, T. A., Adebayo, A. S., Ogunleke, J. D., Abass, T. B., Oyedare, T. A., Adetutu, T. J., Adeeyo, A. O., & Oyedemi, A. A. (2020). An appraisal of the drinking water quality of groundwater sources in Ogbomoso, Oyo state, Nigeria. *Groundwater Sustainable Development,* 11: 10.

[8] Bridge, J. W., Oliver, D. M., Chadwick, D., Godfray, H. C., Heathwaite, A. L., Kay, D., & Banwart, S. A. (2010, May 10). Engaging with the water sector for public health benefits: waterborne pathogens and diseases in developed countries. *World Health Organization*.

[9] Carpenter D. O. (2011). Health effects of persistent organic pollutants: the challenge for the Pacific Basin and for the world. *Revised Environmental Health.* 26 (1).

[10] Canni, K. F., Thomas, D. R., Salmon, R. L., Wyn-Jones, A. P., & Kay, D. (2012). *SYSTEMATIC REVIEW: Extreme water-related weather events and waterborne disease.* Cardiff, UK: Cambridge University Press.

[11] Chia, M., & Oniye, S. (2013). Domestic Water Quality Assessment: Microalgal and Cyanobacterial Contamination of Stored Water in Plastic Tanks in Zaria, Nigeria. *European Journal of Scientific Research*.

[12] Dahunsi, S. O., Owamah, H. I., Ayandiran, T. A., & Oranusi, S. U. (2014). Drinking water quality and public health of selected towns in South Western Nigeria. *Water Quality Expert Health.* 6 (3): 143–153.

[13] Ebele, A. J., Oluseyi, T., Drage, D. S., Harrad, S., & Abou-Elwafa Abdallah, M. (2020). Occurrence, seasonal variation and human exposure to pharmaceuticals and personal care products in surface water, groundwater and drinking water in Lagos State, Nigeria. *Emerging Contaminants.* 6: 124–132.

[14] Edungbola, L. D., & Asaolu, S. O. (1984). A Parasitological Survey: Onchocerciasis in Babana District of Kwara State, Nigeria. American Journal of Tropical Medicine & Hygiene. 33 (999): 1147-1154.

[15] Ezekwe, C. I., & Chima, G. N. (2013). An Investigation of Selected Microbial Pollutants in Groundwater Sources in Yenagoa, Bayelsa, Nigeria. *Artigo Original*, 35 (84): 77-84.

[16] Fawell, J., & Nieuwenhuijsen, M. J. (2003). Contaminants in Drinking Water. *British Medical Bulletin*, 68: 199-208.

[17] Ighalo, J. O., & Adeniyi, A. G. (2020). A comprehensive review of water quality monitoring and assessment in Nigeria. Elsevier Limited, 260.

[18] Kolawole, O. M., Ajayi, K. T., Olayemi, A. B., & Okoh, A. I. (2011). Assessment of water quality in Asa River (Nigeria) and its indigenous Clarias gariepinus fish. *International Journal of Environment & Resource Public Health.* (11): 4332–4352.

[19] Meride, Y., & Ayenew, B. (2016). Drinking water quality assessment and its effects on residents health in Wondo genet campus, Ethiopia. *Environmental Systems Research - Springer*, 5: 1.

[20] Muyi, T. D. (2007). Water and the Body. Daily Sun. Tuesday, August 7, 2007 edition p. 3.

[21] Nnorom, I. C., Ewuzie, U., Eze, S. O. (2019). Multivariate statistical approach and water quality assessment of natural springs and other drinking water sources in Southeastern Nigeria. 5 (1).

[22] Ogunbanwo, O. M., Kay, P., Boxall, A. B., Wilkinson, J., Sinclair, C. J., Shabi, R. A., Fasasi, A. E., Lewis, G. A., Amoda, O. A., & Brown, L. E. (2020). High concentrations of pharmaceuticals in a Nigeria river catchment. *Environ. Toxicological Chemistry,* 0–2.

[23] Oguntoke, O., Aboderin, O. J., & Bankole, A. M. (2009). Association of water-borne diseases morbidity pattern and water quality in parts of Ibadan City, Nigeria. *Journal of Health Research*, 11 (4).

[24] Oparaocha, E. T., Iroegbu, O. C., & Obi, R. K. (2010). Assessment of the Quality of Drinking Water Sources in the Federal University of Technology Owerri, Imo State, Nigeria. *Journal of Applied Biosciences*, 32.

[25] Orisakwe, O. E., Igwilo, I. O., Afonne, O. J., Maduabuchi, J. M. U., Obi, E., & Nduka, J. C. (2007). Heavy Metal Hazards of Satchet Water in Nigeria. *Archives of Environmental & Occupational Health*, 61 (5).

[26] Saheed, A. B. (2010). Poverty situation in Nigeria: an overview of rural development institutions. *Pakistan Journal of Social Sciences*, 7 (5): 351-356.

[27] Umeuduji, J. E., & Aisuebeogun, A. (1999). Relief and Drainage. In C. U. Oyegun, & A. Adeyemo, *Port Harcourt Region* (33-42). Port Harcourt: Paragraphics.

[28] Ukaogo, P. O., Ewuzie, U., Onwuka, C. V. Environmental pollution: causes, effects, and the remedies. (2020). *Microorganism Sustainable Environmental Health.* 419–429.

[29] WHO. (2000). *Global Water Supply and Sanitation Assessment.* Geneva: World Health Organization.

[30] Yusuff, A. S., John, W., Oloruntoba, A. C., & Babalola, A. (2014). Review of Prevalence of Waterborne Diseases in Nigeria. *Journal of Advancement in Medical and Life Sciences*.