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# Open Defecation and Water-Related Parasitic Diseases Burden: Case Study in Nigeria — A Review

Amadi E.C.[1,2,3], Ike A.C.[1], Eze E.A.[1], Onah I. Enemour S.[2] & Imanyikwa I.O.[2]

[1] Department of Microbiology, University of Nigeria, Nsukka, Enugu State, Nigeria

[2] Department of Medical Microbiology, College of Medicine, Enugu State University of Science and Technology, Parklane Campus, GRA, Enugu, Enugu State, Nigeria

[3] Department of Microbiology, Caritas University, Amorji-Nike, Emene, Enugu, Enugu State, Nigeria

Correspondence: Amadi E.C., Department of Microbiology, University of Nigeria, Nsukka, Enugu State, Nigeria; Department of Medical Microbiology, College of Medicine, Enugu State University of Science and Technology, Parklane Campus, GRA, Enugu, Enugu State, Nigeria; Department of Microbiology, Caritas University, Amorji-Nike, Emene, Enugu, Enugu State, Nigeria.

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**Abstract**

Open defecation and its water-related parasitic diseases burdens are very grave health issues in Nigeria, all underdeveloped/developing countries; and large populations are at risks. Study was based on data collection through primary and secondary sources. 20% of Nigerians still openly defecate and stands 25$^{th}$ in the world rating; most Europe and North America is free of this habit, and 68% Niger Republican still indulge and they're the worst in the world. It is most common where toilet facilities, pipe borne water, poor sewage disposal, homeless and illiteracy thrive. It's done by various methods; government/non-government agencies, enlightened/semi-literate/literates (e.g., undergraduates in hostels) are involved. Burdens of this habit politically, economically, health-wise, and socially is heavy. Associated water-related parasitic pathogens which contaminate water resources include: Protozoa (9); Platyhelminthes (13); and nematodes (7). Burdens/effects, of various serious diseases, are high on the nation. Open defecation is the major means of seeding parasites into soils/water-resources/bodies. Rural communities are at highest risk of these parasitic-water-borne diseases. Implications of these findings suggest that parasitic organisms are maintained by a viable ecosystem in remote settlements/many urban areas among the poor. Preventive measures: boiling/treating potable water; government/non-governmental agencies provision of pipe-borne water; wells, ponds, bore holes, streams; protections of water-resources from contaminations.

**Keywords:** open defecation, parasites of human biotic origins, water-related parasites, diseases, water, Nigeria

## 1. Introduction

There is need to look into the issues of open defecation (Figure 1) and water-related parasitic diseases burden in Nigeria, pari *passu* the whole world as an entity. This is because of the very serious health hazards that can emanate or be associated with it, especially the very high number of the population that is at risk, the rate of morbidity and mortality. By definition, WHO, (2013) defined open defecation as when human feces are disposed of in the fields, forests, bushes, open bodies of water, beaches, and other open spaces. Corollary, they also quickly explained that improved sanitation facilities are those that hygienically separate human excreta from human contact. Further, they as well defined its relationship with improved drinking-water sources as those that, by the nature of its construction, adequately protects the sources from outside contamination, in particular from fecal matter.

It is absurd that from information from WHO, (2013), 15% of the world population (1 billion) still practice open defecation and 90% of all open defecation takes place in rural areas. Nigeria constitutes a good percentage of both factors. This is because majorities (71%) of those without sanitation live in rural areas. However, globally, open defecation rates declined from 24% in 1990 to 15% in 2011, which signifies a drop of 250 million people to 1.04 billion in 2011. But, unlike Nigeria, Eastern Asia, South East Asia, Latin America and Caribbean regions have seen a steady decline (Table 2). It is only in Nigeria, including the entire sub-Saharan Africa are open defecation still increasing (WHO, 2013) (Table 2).

The reason for this is nothing but poor sanitation. According to UNICEF, (2013) statistics, until 1990, only about 1.9 billion people gained access to an improved sanitation facility; in 2011, only almost two thirds (64%) of the world population relied on improved sanitation facilities. However, by end of 2011, they further pointed out that only 2.5 billion people (out of about 7 billion world population) lacked access to an improved sanitation facility, out of which 761 million use public or shared sanitation (i.e., "face-me-I-face-you," as coded in Nigeria) facilities and another 693 million use facilities that do not meet minimum standards of hygiene. Nigeria constitutes a "big-slice" of this portion. It is so saddening, as was also noted, that the world remains off track to meet the Millennium Development Goal (MDG) sanitation target, which requires reducing the proportion of people without access from 51 percent to 25 per cent by 2015.

They further statistically attributed their reasons to the fact that 89% of people in the world did not used an improved drinking-water source by end of 2011; only about 55% world population enjoyed the convenience and associated health benefits of a piped water supply on premises, and that an estimated 768 million people did not use an improved source for drinking-water in 2011; worst of all, about 185 million relied on surface water (like Adada River in Enugu state, Nigeria) to meet their daily drinking-water needs. It must be sadly noted too that among the 55% of world population that enjoyed the convenience and associated health benefits of a piped water supply on premises included Enugu metropolis; all the inhabitants are witness to the facts that: (a) the facility did not cover the up to 60% of the metropolis in 2011 when it was commissioned; (b) the 60% covered then had declined to less than 10% because of non-functionality.

According to Premium Times (2021), FG says Nigeria still has the highest number of persons in the world defecating openly, and that Federal Government has identified Kwara and Plateau as the states with the highest population who engage in open defecation. One of its officials also said that Nigeria still has the highest number of persons defecating openly. The Director, Water Quality Control and Sanitation, Ministry of Water Resources, Emmanuel Awe, disclosed this at the 2021 First Quarter Lunch Time Seminar for Media Executives in Abuja (Premium Times, 2021).

Premium Times (2021) further stated that about 46 million Nigerians are said to practice open defecation, making the country the second in the world with such unhealthy practice (but this was not true, according to information from WHO, 2021). And that only India ranked worse than Nigeria in the Water Sanitation and Hygiene (WASH NORM) survey conducted by the United Nations Children's Fund (UNICEF); and, that the Nigerian Ministry of Water Resources and National Bureau of Statistics took part in the Nigerian survey. The survey also found that only 11 of the 774 local government areas (LGA) in Nigeria are free from the practice of open defecation. This literature cannot imagine any of such 11 LGA that is so free.

The fundamentals of open defecations and its associated burden in Nigeria have just been glanced through. The major resultant danger of this is fecal pollution of recreational water, domestic water supply, agricultural water sources, which can lead to health problems because of the presence of infectious microorganisms and parasites, derived from such open defecation of human or animals and dumping of human sewage. Recreational water activities where whole-body contact takes place or those in which there is a meaningful risk of swallowing the water are also problems.

### *1.1 Aim*

The aim of this review was to look into the issues of open defecation and water-related parasitic diseases burden in Nigeria.

### *1.2 Specific Objectives*

The specific objectives were: (i) collection of data through primary and secondary sources; (ii) the primary source was based on interview and literature survey from internet and journal publications; (iii) the secondary data were from reports and publications of various private and government institution; (iv) data collections were on open defecation, and water-related parasitic diseases burden, with Nigeria in scope, *pari passu* the world as entity; (v) these were with a view to assessing the successes recorded and problem encountered by governments; (vi) analyze the trend and spatial dimension of these diseases in Nigeria, *pari passu* the world as entity, and; (vii) suggest necessary recommendations for proper management of the two problems.

## 2. Sources of Information

The study was based on data collection through primary and secondary sources. The primary source was based on interview, literature survey from internet and journal publications while the secondary data were from report and publications of various private and government institution. Data collections were on open defecation, and water-related parasitic diseases burden, with Nigeria in scope, *pari passu* the world as an entity. These were with a view to assessing the successes recorded and problem encountered by governments, the nation in general, and analyze the trend and spatial dimension of these diseases in Nigeria, *pari passu* the world as entity, and highlighting areas in need of urgent intervention as well as suggest necessary recommendations for proper management of the two problems.

*2.1 Scope*

The two problems were looked into and discussed in the following order: (i) people that defecate openly and how they do it; (ii) people practicing open defecation (% of nations' population); (iii) burdens of open defecation; (iv) open defecation and how it affects human health; (v) fecal pollution and its associated health effects; (vi) water-related parasites and parasitic diseases; (vii) parasitic pathogens associated with water and their various diseases; (viii) relationship of open defecation and water-related parasites and parasitic diseases; (ix) solutions, conclusions and recommendation.

## 3. Results and Discussions

*3.1 People that Defecate Openly and How*

From survey, people that openly defecate (Figure 1) and how they practice it is summarized in Table 1. Further, if the two definitions of open defecation by WHO/UNICEF (2017a) and Conserve energy future, (2021) are patently looked at, both private and federal/state waste disposal organizations are open defecators; otherwise, how does one classify how human wastes are simply dumped into the valley, river or oceans as is seen, like at Iddo in Lagos, or Eva/Onyema Valleys in Enugu, both in Nigeria, etc., instead of being properly incinerated, as knowledge in microbiology and parasitology will recommend.

Table 1. People that defecate openly and how they do it

| Serial No. | People that open defecate | How they open defecate |
|---|---|---|
| 1 | Street beggars | Defaecate directly into gutters and nook and corners (Figure 1) |
| 2 | Shop apprentice in the market | Defaecate into papers or polythene bags inside their shops, and later throw them into gutters or waste bins |
| 3 | Shop keepers in town | Defaecate into papers or polythene bags inside their shops, and later throw them into gutters or waste bins |
| 4 | Motor cycle ("Okada") commercial riders | Defaecate at any available hidden nooks and corners |
| 5 | Tricycle ("Keke") commercial riders | Defecate at any available hidden nooks and corners |
| 6 | Herdsmen | Defaecate at surrounding bushes |
| 7 | Homeless | Defaecate at any available hidden nooks and corners |
| 8 | Night watchmen ("Meguards") | Defaecate into gutters and nook and corners |
| 9 | Students in hostels in some of our federal and state-owned tertiary institutions | In a parlance popularly known as "throwing shot-put" |
| 10 | Praying religious men | Habits before praying |
| 11 | Farmers and hunters | Defaecate at surrounding bushes or farm |
| 12 | Agents of private, federal and state governments waste disposals | Dumping of human and animal wastes in water bodies (e.g., Iddo in Lagos), lands, valleys (e.g., Onyema valley in Enugu), etc. |
| 13 | The poor, the illiterate and semi-illiterate, mostly in rural areas | Because they don't have toilet facilities, they simply defecate in the surrounding bushes |
| 14 | Some swimmers | From mere idiocy, especially when recreationally swimming, even in swimming pools |

| | | |
|---|---|---|
| 15 | Open grazing | Excreta from droppings from free roaming animals (even children) and (they are particularly hazardous and a potential source of health problems in both urban and rural communities) |

Source: Compilation summary from literature survey.

Percentage of people in all the countries of the world that practice open defecation, ranges from zero percent (0%) (e.g., United States of America, France, etc.) to, as high as sixty-eight percent (68% (i.e., Niger Republic)) are shown in Table 2. From the WHO/UNICEF (2017b, c) latest report in the Table 2, 20% of Nigerians still practice open defecation. Nigeria shockingly was ranked beneath United Nation's classified "Least developed countries" (that has18%) and of "Fragile and conflict affected situations" (that has 19%); and also shamefully beneath other less-better-off countries like: Uganda (6%); Cameroon, Djibouti and Mali (7%); Democratic Republic of Congo and Tanzania; Afghanistan (13%); Guinea, Papua, New Guinea and Senegal (14%). But, ranked just marginally by only 1% above "Heavily indebted poor countries (HIPC)" and South Asia.

Besides, the indication in Table 2, Conserve Energy future, (2021) also, indicated that open defecation is associated with rural and poverty-stricken regions of the world, especially Sub-Sahara Africa (of which Nigeria is inclusive) and Asia; and that statistics from around the world have shown that it has statistical relationship with parts of the world that do not use toilet or human waste facilities and with low education and poverty.

Figure 1. Man defecating in an open drainage

Source: Premium Times, (2021). Nigeria still has highest number of persons defecating openly-Official. Available at: https://www.premiumtimesng.com/news/more-news/462922-nigeria-still-has-highest-number-of-persons-defecating-openly-official.html (Accessed August 23, 2021).

Table 2. People practicing open defecation (% of nations' population)

| **Year** | **Countries** | **% practicing open defecation** |
|---|---|---|
| 2017 | Albania, Andora, Antigua and Barbuda, Antigua and Barbuda, Australia, Armenia, Azerbaijan, Austria, Bahamas; Bahrain, Bangladesh, Barbados, Belarus, Belgium, Bermuda, Bhutan, Bosnia and Herzegovina, British Virgin Islands, Canada Cayman Islands, Channel Islands, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Curacao, Cyprus, Czech Republic, Egypt, Arab Rep., Estonia, Fiji, Faroe Islands, Finland, France, Georgia, Germany, Gibraltar, Greece, Greenland, Hong Kong SAR, China, Hungary; Iceland, Iraq, Isle of Man, Ireland, Israel, Italy, Jordan, Japan, Kazakhstan, Korea, Dem. People's Rep., Korea Rep., Kosovo, Kuwait, Kyrgyz Republic, Latvia, Lebanon, Libya, Liechtenstein, Lithuania, Luxembourg, Malaysia, Maldives, Malta, Mauritius, Moldova, Monaco, Montenegro, Netherlands, New Caledonia, New | 0% |

| | | |
|---|---|---|
| | Zealand, Northern Mariana Islands, Norway, Oman, Puerto Rico, Qatar, Romania, Russian Federation, North Macedonia, Palau, Paraguay, Poland, Portugal, Samoa, Saudi Arabia, Serbia; Seychelles, Singapore, Sint Maarten (Dutch part), Slovak Republic, Slovenia, Spain, St. Kitts and Nevis, Sweden, Switzerland, Tajikistan, Thailand, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, United States of America; Uruguay, Uzbekistan, Virgin Islands (U.S.); West Bank and Gaza | |
| | **Central Europe and the Baltics; Euro area; Europe & Central Asia; Europe & Central Asia (excluding high income); European Union; North America; OECD members; High income of Sub Sahara.** | |
| 2017 | Algeria, Aruba, Barbados, Guyana, American Samoa, Belize, Brazil, Comoros, El Salvador, Gambia; Guan, Iran, Islamic Rep., Jamaica, Mexico, South Africa, Sri Lanka, St. Lucia; Syrian Arab Republic, Vanuatu | 1% |
| | **Caribbean small states, Upper middle income** | |
| 2017 | Argentina, Ecuador, French Polynesia, Rwanda; Turks and Caicos Islands | 2% |
| | **East Asia & Pacific; East Asia & Pacific (excluding high income) Latin America & Caribbean; Middle East & North Africa** | |
| | Burundi, Brunei, Darussalam, Dominican Republic; Equatorial Guinea, Gabon, Nauru; St. Martin (French part); St. Vincent and the Grenadines; Suriname; Venezuela, RB; Vietnam. | 3% |
| | **Latin America & Caribbean (excluding high income); Middle East & North Africa (excluding high income).** | |
| | Dominica, Grenada, Panama; Guatemala | 4% |
| | Philippines | 5% |
| | Uganda | 6% |
| | **Arab World** | |
| | Cameroon; Eswatini; Djibouti; Mali; Morocco; Nicaragua; Peru; Tuvalu | 7% |
| | Republic of Congo; Mozambique | 9% |
| | **World; Small states** | |
| | Indonesia; Kenya; Marshall Islands; Mongolia; Pakistan. | 10% |
| | **Other small states; Low & middle income of Sub Saharan; Middle income** | |
| | Botswana, Micronesia, Fed. Sts. | 11% |
| | **Low & middle income of Sub Saharan** | |
| | Congo, Dem. Rep. Tanzania | 12% |
| 2017 | Afghanistan; Bolivia. | 13% |
| | Guinea, Papua New Guinea; Senegal | 14% |
| | **Lower middle income** | 16% |
| | Djibouti, Guinea-Bissau | 17% |
| | **Pacific island small states** | |
| | Ghana, Sierra Leone | 18% |
| | **Least developed countries: UN classification** | |
| | Zambia | 19% |
| | **Fragile and conflict affected situations** | |
| | Nigeria; Angola; Cabo Verde; Haiti; Timor-Leste; Republic of Yemen. | 20% |
| | **Sub-Saharan Africa** | |
| | **Sub-Saharan Africa (excluding high income)** | |
| | Lao PDR; Nepal. | 21% |
| | **Heavily indebted poor countries (HIPC)** | |

| | | |
|---|---|---|
| | **South Asia** | |
| | Ethiopia | 22% |
| | **Low income** | |
| | Central African Republic; Sudan | 24% |
| | Zimbabwe | 25% |
| | India | 26% |
| | Cote d'Ivoire; Lesotho, Mozambique | 27% |
| | Somalia | 28% |
| | Cambodia, Mauritania | 32% |
| | Liberia | 40% |
| 2017 | Macao SAR, China; Madagascar | 45% |
| | Burkina Faso; Sao Tome and Principe | 47% |
| | Togo | 48% |
| | Namibia | 49% |
| | Benin; Solomon Islands | 54% |
| | Chad, Eritrea, | 67% |
| | South Sudan | 63% |
| | Niger | 68% |

Source: WHO/UNICEF, (2017). People practicing open defecation (% of population) — Nigeria People practicing open defecation, urban (% of urban population). WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Available at: wssinfo.org (Accessed August 22, 2021).

*3.2 Burdens of Open Defecation*

The plight and blight of open defecation, as one of the issues plaguing the Nigeria as a nation, besides putting Nigeria in negative limelight in world polity and geography, its odium cannot be overemphasized. Hence the choice of this topic as a seminar is most appropriate than any other issues in medical/environmental microbiology and parasitology; or probably equal or equivalent to COVID-19. But, like all other tropical diseases and hygiene, it had long been neglected in this part of the world. For instance, in Europe, there has ever been a "Royal Society of Tropical Medicine and Hygiene"; in North America, there has ever been an "American Society of Tropical Medicine and Hygiene"; but nobody ever heard of "African Society of Tropical Medicine and Hygiene" or, a "Nigerian Society of Tropical Medicine and Hygiene?" Yet, the issue involved is tropical issues and hygiene of which Africa and Nigeria are immersed and embedded in; and this spate of open defecation in Nigeria is as well as an unwholesome act with grave adverse health implications that we need to ensure its complete eradication in Nigeria as a whole. Like in other parts of Sub-Saharan, it is an issue of tropical medicine and hygiene.

The genesis is clear; because some people don't have access to toilet facilities, they simply make use of fields, bushes, forests, ditches, streets, canals, and perhaps, worse still, rivers, streams or other water sources; in rare cases, it is simply due to traditional cultural practices, with or without knowledge of its foul implications. Very interestingly, this odious behaviour is not limited to only inhabitants of rural, underdeveloped, areas of poor ignorant illiterate or semi-literate people alone; so sadly, it is rather common practice in some of our federal and state-owned tertiary institutions in a parlance popularly known as "throwing shot-put." The existence of this practice in our supposed-to-be-literate tertiary institutions probably accounts for the failure of the universities' institutions management to adequately manage their hostels. By extension, the governments too are accountable — through failure in providing conducive learning atmospheres for students whereby basic human needs such as availabilities of basic toilet facilities, are, probably counted as an unnecessary luxury. Therefore, burdens of this open defecation, besides the negative limelight in world polity and geography as mentioned earlier, also extend to many serious, social, health and economic implications.

According to Premium Times (2021), Awe, the Director, Water Quality Control and Sanitation, Ministry of Water Resources, Federal Republic of Nigeria, indicated that the impact of poor sanitation was seen in underdevelopment of children, loss of manpower, low socioeconomic development, among others. The director also identified open defecation as a major contributor to rising cases of kidnapping, rape and sexual violence,

noting that this could occur as a result of searching for convenient places to answer the call of nature. He said that the data was obtained from the Water, Sanitation and Hygiene National Outcome Routine Mapping Survey (WASH-NORM), launched in 2018 to fill the chronic gaps in monitoring and routine assessment of the status of the WASH services in Nigeria. According to him, Nigeria still has the highest number of persons defecating openly, also saying that no less than N455 billion was lost annually to poor sanitation.

In Nigeria, open defecation was estimated at over 46 million people — a practice which has had a negative effect on the populace and has contributed to the country's failure to meet the United Nations Millennium Development Goals (MDGs) (Premium Times, 2021).

Furtherance to that, major burden of open defecation lies on the fact that parasitic infections affect work and productivity since they are usually associated with very diminished capacity to carry out physical work which is of big significance because in many countries (such as Nigeria) hard physical work is the means by which families grow their food. Consequently, Chance and Evan (1999) and WHO (2008) estimated that food- and water-borne infectious diseases currently infect 3.5 billion people in developing countries and its mortality is about 160,000 deaths per annum, with 80% of these occurring in children under 5 years of age.

Adegoke (2000), also noted that human excreta are important sources of pathogenic organisms, especially the intestinal parasites that are causes of a high morbidity in the general population primarily due to inadequate disposal of excreta and lack of personal hygiene and that most urban and rural communities in the under-developed and developing countries do not have adequate disposal system for human waste; consequently, many inhabitants defecate indiscriminately in places not far from their dwelling abodes, which include directly on the soil and rocks, by the sides of the streams, home ponds, wells; and in some cases into the streams, especially when recreationally swimming. Likewise, Ukoli (2000) indicated that excreta from children and droppings from free roaming animals are particularly hazardous and a potential source of health problems in both urban and rural communities.

According to Adeyinka et al. (2014), Table 3 showed that Dracunculiasis is among four most common water related diseases in Nigeria between 2002-2008; illness from *D. medinensis* include abdominal discomfort (cramping), fever, vomiting, diarrhea, loss of weight and fatigue.

Table 3. Cases of Four Most Water related Diseases in Nigeria (2002-2000): Dracunculiasis VS Three bacteria

| **Disease** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
|---|---|---|---|---|---|---|---|
| Cholera | 23,441 | 11,933 | 13,522 | 10,785 | 20,526 | 12,194 | 17,854 |
| Dracunculiasis | 2,588 | 1,234 | 2,206 | 153 | 36 | 1 | Na |
| Hepatitis | 9,451 | 8,894 | 7,104 | 13,609 | 6,419 | 5,239 | Na |
| Typhoid | 104,154 | 77,850 | 39,337 | Na | Na | Na | Na |

Source: Adeyinka et al. (2014).

The sequelae of this open defecation also fall on our water resources. In the northern Nigeria, among different types of water samples examined by Abdullahi et al. (2018) pond water had the highest contamination of parasites (100%), followed by Dam (63.3%), well (22.9%), tap (10%) and boreholes (0%). The major parasitic protozoans detected from the samples in their cystic form are *E. histolytica* and *G. lamblia* with mean prevalence of 13.7% and 7.8% respectively; both statistically significant. The prevalence of *E. histolytica* and *G. lamblia* in the dry season was 8.8% and 6.9% respectively, while that of the wet season was 18.6% and 8.8% respectively. They also indicated that the sources of contaminations are fecal from open defecation that is common practice in the area.

In western Nigeria, Simon-Oke et al., (2013) found of all the water sources, stream water samples recorded the highest prevalence (45%), well water (24%) next, rain water (21%), and borehole water significantly having the least prevalence of 10%. Isolated protozoa parasites were *Cryptosporidium parvum* (33.2), *Giardia* spp (19.9), and *Entamoeba histolytica* (10.3%). Helminths isolated were *Dracunculus medinensis* and *Enterobius vermicularis* (4.0%). All the water sources harbored at least one parasite except just one of the borehole waters sources. Chollom et al. (2013), also in western Nigeria indicated that 59 out of 100 water sources analyzed have parasitic infestation. Ponds also had the highest degree of parasitic contamination (78.3%), streams followed next with 50%, while wells had 35%, while bore holes had 0%. However, helminths were the leading parasitic genera isolated, with *Ascaris* species accounting for 33.9% of the parasites. Hookworm was the second most common helminths with the prevalence of 20.3%.; S*trongyloides* spp accounted for a paltry prevalence of 3.4%. Protozoan isolated in this case were *Balantidium coli*, accounting for 18.6% and *Entamoeba histolytica* (18.6%).

In eastern Nigeria, Amadi and Onyemelukwe (2014) isolated *Strongyloides stercoralis*, Hookworm, *Giardia lamblia*, *Entamoeba histolytica*, *Strongyloides stercoralis*, *Chilomastix mesnili*, *Giardia lamblia*, *Blastocystis hominis*, *Taenia spp.*, and *Ascaris lumbricoides* in the rainy season; in the dry season, *Isospora belli*, *Strongyloides stercoralis*, *Giardia lamblia*, *Ascaris lumbricoides*, *Entamoeba coli*, *Giardia lamblia*, *Entamoeba histolytica*, Hookworm, *Cryptosporidium spp.*, *Ascaris lumbricoides*, and *Clonorchis sinensis*.

*3.3 Open Defecation and How It Affects Human Health*

Water generally contains a mixture of pathogenic and non-pathogenic parasites (and microorganisms). These parasites and microbes are derived from contaminations from open defecation and/or shedding from livestock (e.g., cattle, sheep), industrial processes, farming activities, domestic animals (such as dogs, cats, etc.; birds like chicken, turkey, ducks, etc.) and wildlife. The people utilizing such water as resources (whether for domestic, agricultural or recreational purposes) stand in great or grave danger, depending on the types of pathogenic parasitic or microbial pollutant/contaminants. Consequently, the above statements briefly define the precisely relationship between open defecation and how it could affect human life.

These contaminants or pollutants definitely include pathogenic organisms that cause gastrointestinal infections following ingestion or infections of the upper respiratory tract, ears, eyes, nasal cavity and skin as can be contracted, surprisingly even in swimmers whether in surface water or recreational pools. Infections and illness due to recreational water contact are generally mild and so difficult to detect through routine surveillance systems. Even where illness is more severe, it may still be difficult to attribute them to water exposure. Targeted epidemiological studies, however, have shown a number of adverse health outcomes (including gastrointestinal and respiratory infections) to be associated with fecally polluted waters in use (Teunis, 1996; Teunis et al., 1999; Okhuysen et al., 1999). This can result in a significant burden of disease and economic loss. The number of microorganisms (dose) that may cause infection or disease depends upon the specific pathogen, the form in which it is encountered, the conditions of exposure and the host's susceptibility and immune status. For viral and parasitic protozoan illness, this dose might be very few viable infectious units (Fewtrell et al., 1994; Teunis, 1996; Haas et al., 1999; Okhuysen et al., 1999; Teunis et al., 1999). In reality, the body rarely experiences a single isolated encounter with a pathogen, and the effects of multiple and simultaneous pathogenic exposures are poorly understood (Esrey et al., 1985); hence, numbers and type of pathogens (and consequent individual burden and specific effects on health) will vary greatly across different parts of the world and times of year as had been noted by many authors (Amadi & Onyemelukwe, 2014; Adeyinka et al., 2014; Simon-Oke et al., 2013; Abdullahi et al., 2018).

The public is not aware beyond the cosmetic values that it is not even microbiologically or parasitologically safe to even swim in polluted water; some parasites of human biotic origin such as *Strongyloides stercoralis, Ancylostoma duodenales* and *Necator americanus* larvae can penetrate any part of intact skins and cause various types of serious diseases. In both marine and freshwater studies by (Prüss, 1998) of the impact of fecal pollution on the health of recreational water users, several fecal index bacteria, including fecal streptococci/intestinal enterococci (even parasites Amadi et al., 2020, 2021), have been used for describing water quality. Although Pruss, (1998) indicated that the bacteria were not postulated as the causative agents of illnesses in swimmers, but it appears to behave similarly to the actual fecally derived pathogens; however the grave dangers of parasites like *S. stercoralis* and *A. duodenale* and *Necator americanus*, etc. whose larvae can penetrate any part of intact skin had been noted too (Amadi et al., 2020, 2021). Prüss (1998) indicated that available evidence suggests that the most frequent adverse health outcome associated with exposure to fecally contaminated recreational water is enteric illness, such as self-limiting gastroenteritis, which may often be of short duration and may not be formally recorded in disease surveillance systems. Transmission of pathogens that can cause gastroenteritis is biologically plausible and is analogous to waterborne disease transmission in drinking-water, which is well documented (Prüss, 1998). The association has been repeatedly reported in epidemiological studies, including studies demonstrating a dose-response relationship (Prüss, 1998).

*3.4 Water-Related Parasites and Parasitic Diseases*

Water-related parasite and its diseases as a burden can now be easily explained. By definition, parasites are organisms that assume a position by which they choose as a way of life to live in or attached to another organism, generally referred to as hosts, thereby deriving benefits such as nutrition, accommodation, transportation, protections, etc., with or without any reciprocation benefit to the host; they however become problems when they cause pathological irritations, referred to as diseases, some of which can even lead to death. Many of such parasites are water-borne; many are as well associated with many different kinds of diseases, summarized in Table 4.

Water, part-subject of this topic need to be defined: it is the common name assigned to the liquid state of hydrogen-oxygen compound, with the molecular formula $H_20$, chemical structure of H-O-H, and IUPAC name of hydrogen/hydroxonium ion (depending on the oxidation state); the solid state is known as ice, while the

gaseous state is called steam (Amadi et al., 2014). It naturally and artificially exists in many forms as follows: surface water (i.e., oceans, seas, river, streams, rivulets, etc.) or underground waters (i.e., springs, well or aquifers) or artificial waters (i.e., dams, boreholes, wells, underground tanks) or atmospheric waters (i.e., rain, snow, hail, sheet, etc.); and its usages include agricultural, recreational, industrial, potability or domestic.

Diseases (as syndromes that can emanate from water-borne parasites), need also be defined in this context: It is noted as any deviation from normal growth, metabolic order, physiological functions and structures of an organism, or part of it that is sufficiently pronounced to produce viable symptom(s) or impair quality or economic value(s) and patient's natural abilities and genetic potentials. These water-borne diseases are usually acquired by the consumption of polluted water containing human and animal fecal matter from patients or healthy carriers (Chigor et al., 2012; Camcross & Feacham, 1993), or through active penetration of any part of intact skins Faust and Rusell (1964); Faust et al., (1977). Water-borne parasites and the diseases they cause are summarized in Table 4.

Table 4. Parasitic pathogens associated with water and their various diseases

| **Parasitic pathogens** | **Diseases caused** |
|---|---|
| **Pathogenic Protozoa** | |
| *Giardia lamblia* | Giardiasis, a type of gastroenteritis |
| *Entamoeba histolytica* | Amoebic dysentery and liver abscess |
| *Cryptosporidium partum* | Cryptosporidiosis, a type of enteritis and secretory diarrhea. |
| *Cyclospora cayetanensis* | Typified by cramp, muscle pain, vomiting fever, etc. |
| *G. hominis* | Typified by mild diarrhea |
| *Isospora species (i.e. I. belli and I. hominis)* | Isosporiasis, a mild diarrhea, but can be serious complication in immuno-compromised |
| *T. hominis* | Commensal |
| *Toxoplasma gondii* | Toxoplasmosis, consisting of many complications, including abortion, particularly in immuno-compromised |
| *Balantidium coli* | Balantidiasis, an enteritis that may lead to complication such as intestinal ulceration |
| **Nematodes** | |
| *Trichuris trichiura* | Trichuriasis, the parasitic etiologic agent of rectal prolapsed (pile or haemorrhoid), etc. |
| *Enterobius vermicularis* | Enterobiasis, typified by very intense anal itch, which can cause psychiatry in infants and neonate, etc. |
| *Ascaris lumbricoides* | Ascariasis, major complications being intestinal obstruction/occlusion (Table 2), malnutrition, etc. |
| *Trichostrongylus spp* | Gastrointestinal disturbances |
| *Strongyloides stercoralis* | Strongyloidiasis, a gastroenteritis, but with complication only in retro-infection which can happen in constipated stool. |
| *Ancylostoma duodenale* | Ancylostomiasis, a gastrointestinal disturbance, intense stomach ache; complication mainly anaemia |
| *Necator americanus* | Necatoriasis, a gastrointestinal disturbances, intense stomach ache; complication mainly anaemia |
| *Wuchereria bancrofti* | Bancrofti filariasis, typified by elephantiasis particularly of a scrotum that need transporting in wheel-barrow |
| *Onchocerca volvulus* | Onchocerciasis, best known as River blindness, accountable for major blindness in northern Nigeria as seen in "Aboki beggars" |
| *Dracunculus medinensis* | Dracunculiasis (Guinea worm infection) |
| **Pathogenic Platyhelminthes (Flukes)** | |

| | |
|---|---|
| *Taenia solium* | Taeniasis, a gastrointestinal disorder, malnutrition malady, serious complication being cysticercosis in man |
| *T. saginata* | Taeniasis, a gastrointestinal disorder, malnutrition malady |
| *Dipylidum caninum* | Taeniasis, Dog tapeworm infection |
| *Hymenolepis nana* | Hymenolepiasis, anal itch |
| *Multiceps multiceps* | Coenuruses, inter-cranial tension, gid, a very serious surgical and medical emergency with very grave prognosis |
| *Schistosoma haematobium* | Urinary schistosomiasis, typified by blood in the urine; complications include hepatomegaly, splenomegaly, renal failure, death in untreated hype-infection |
| *S. mansoni* | Intestinal schistosomiasis, complications include hepatomegaly, splenomegaly, renal failure, death in untreated hyper-infection |
| *S. japonicum* | Oriental intestinal schistosomiasis, complications include hepatomegaly, splenomegaly, renal failure, swollen abdomen, death in untreated hyper-infection |
| *Echinococcus granulosis* | Echinococciasis, a hydatid disease. |
| **Indirectly water-borne pathogenic flukes** | |
| *Fasciola hepatica* | Fascioliasis hepatitis, etc. |
| *Heterophyes heterophyes* | Heterophyiasis, typified by abdominal pain and diarrhoea; serious complications if the egg gets into the brain (Oxford concise medical dictionary, 2010) |
| *Metagonimus yokogawai* | Hepatitis, etc. |
| *Fasciolopsis buski* | Hepatitis, etc. |
| *Dicrocoelium dendriticum* | Hepatitis, etc. |

Source: Compilation summary from literature survey.

Figure 2. Burden of open defecation: About 100 *Ascaris lumbricoides* worms surgically excised from a 7 years-old female child in a University Teaching hospital in Enugu, Nigeria in 2013

*3.5 Relationship of Open Defecation and Water-Related Parasites and Parasitic Diseases*

Open defecation has been, thus clearly defined. By open defecations, the human fecal wastes that are deposited

in the environment (besides those directly seeded into water bodies) are ultimately regularly washed into the communities' water bodies by rains and sewerages. These feces contain pathogens that are seeded in the soil where they pollute the water as well as fresh vegetables, thereby constituting threats to public health (Assafa et al., 2004).

Thus, etiology of this water and vegetable contamination has been nailed to seeding of the soil with these pathogens by these unhealthy, unwholesome human activities as listed in Table 2. The parasitic water borne diseases became a source of concern to the people due to continued contamination of water from different sources as a result of these unwholesome human activities. The excreta-related communicable diseases further become a major problem in areas where untreated human feces are used as manure (Alli et al., 2011). By communicability, we mean infection or infestation of human beings.

Infection or infestations are defined as: the pathological conditions due to successful adhesion, penetration, colonization and growth of parasites (including microbes) in a host, (that consequently leads to various disease conditions), including those enumerated in Table 4 for water-related parasites. In consequence, parasitized or infected patients fall sick or lose their health, thereby are unable to carry out their physiological, metabolic, anatomical and physical functions to the best of their abilities and genetic potentials.

*3.6 Solutions, Conclusions and Recommendation*

3.6.1 Solution

As the saying goes, it is incomplete to discuss "biodegradation" or "bio-deterioration", without indicating its bioremediation: efforts are indeed on the way for remediation of the sordid problem, one of which is an Executive Order 009 titled 'The Open Defecation-Free Nigeria by 2025 and Other Related Matters Order' issued President Muhammadu Buhari of Nigeria. The order is intended to put all hands on the deck to tackle the problem and put an end to the bad habit (Premium Times, 2021).

According to Adebowale (2019), the signing of the order is to ensure Nigeria becomes open defecation free by 2025; further, that details of the executive order sent to Premium Times was signed by Buhari's spokesperson, Femi Adesina. The Order declares as follows:

1) That by this Order, Nigeria is committed to being open defecation free by 2025.

2) That the National Open Defecation Free (ODF) Roadmap developed by the Federal Ministry of Water Resources with support from other key sector players across Nigeria be put into effect.

3) a. There is established in the Federal Ministry of Water Resources a National Secretariat called "Clean Nigeria Campaign Secretariat". b. The Secretariat is authorized on behalf of the President to implement this Order by ensuring that all public places including schools, hotels, fuel stations, places of worship, marketplaces, hospitals and offices have accessible toilets and latrines within their premises.

4) All Ministries, Departments and Agencies (MDAs) of government shall cooperate with the Clean Nigeria Campaign Secretariat.

5) The National Assembly and the State Houses of Assembly shall enact legislation on the practice of open defecation with appropriate sanctions and penalties.

6) All development projects shall include construction of sanitation facilities as an integral part of the approval and implementation process.

7) The Secretariat shall terminate when Nigeria is declared Open Defecation Free.

8) All enforcement authorities are hereby directed to diligently collaborate with the Federal Ministry of Water Resources in implementing this Order.

The Executive Order 009 came into being against the background that:

Nigeria is ranked second amongst the nations in the world with the highest number of people practicing open defecation that was estimated at over 46 million people — a practice which has had a negative effect on the populace, and has contributed to the country's failure to meet the United Nations Millennium Development Goals (MDGs).

Buhari had described the statistics on open defecation and access to pipe borne water service and sanitation as disturbing, and had declared commitment to implement the National Water Supply, Sanitation and Hygiene (WASH) Action Plan.

The President had declared a State of Emergency on Nigeria's water supply, sanitation and hygiene sector, the action being imperative as it will reduce the high prevalence of water borne diseases in different parts of the country which have caused preventable deaths.

Nigeria has committed to end open defecation throughout the country by 2025 in consonance with her

commitment to the United Nations Sustainable Development Goals (SDGs).

The order signed by the President is expected to help address the menace of open defecation in the country.

The order established in the Federal Ministry of Water Resources a National Secretariat called “Clean Nigeria Campaign Secretariat”.

“The Secretariat is authorized on behalf of the President to implement this Order by ensuring that all public places including schools, hotels, fuel stations, places of worship, marketplaces, hospitals and offices have accessible toilets and latrines within their premises.”

According to the report, Femi Adesina, Special Adviser to the President, indicated that This Executive Order took effect from Wednesday, November 20, 2019.

There have also been many other concerted efforts for remedies: Awe (2019) declared, I quote, that “Open defecation contributes to rape and kidnapping cases that we hear about lately, we want everyone to take ownership of building and using their toilets at all times.” He further called for concerted efforts from all Nigerians to do more towards ending open defecation practice. Awe (2019) also said that the ministry has inaugurated 77,400 youth volunteers to act as hygiene ambassadors towards scaling up sanitation and hygiene in the country; that if the country could invest more in sanitation infrastructure, there would be sustainable ways of safe disposal of wastes, business opportunities and improved productivity for all. The Director, Water Supply with the ministry, Benson Ajisegiri, further said the ministry was working to improve access to potable water through the Partnership for Expanded Water Sanitation and Hygiene (PEWASH) programme.

In the opinions of this authors, other counties in the world with this “Open Defecation” problems can emulate this nice and recommendable roadmap developed by Nigeria.

3.6.2 Conclusions

1) Twenty percent (20%) of Nigerian population still defecate openly, ranking her the 25$^{th}$ nation in the world that still practice it;
2) Niger Republic is the country with the highest percent (68%) of its population that is still practicing the odious habit;
3) From the last available record, *Dracunculus medinensis* is the leading water-related parasitic diseases in Nigeria, second only to *Plasmodium* spp;
4) Open defecation is one of the major means of seeding this parasites in the soil, which through rains and sewerages find their way into water bodies, and are most common in remote settlements in Nigeria (to some extent, in some parts of urban areas) where toilet facilities, pipe borne water, poor sewage disposal, homeless and illiteracy thrive most;
5) This revealed that rural communities in Nigeria are at risk of water-borne diseases due to the high rate of parasitic infestation of water source;
6) According to Chollon, et al. (2013), the implications of these findings therefore suggest that parasitic organisms are maintained by a viable ecosystem in remote settlements in Nigeria (and the world) where toilet facilities, pipe borne water, poor sewage disposal, and illiteracy thrives the most;
7) The combined effect of these factors exposes the inhabitants, their children and animals to a cycle of endless parasitism resulting in low productivity, high morbidity and mortality rates in most cases (Adam, 1999);
8) The highest level of government in Nigeria is already aware of the scourge of open defecation and had consequently signed a bill towards that effect.

3.6.3 Recommendations

1) Wells, bore holes, ponds and streams need a great deal of protection from pollution and contamination by potential parasites, micro-organisms and harmful chemical substances, since according to Adam, (1999) these water sources have become sites for breeding and harbouring of many microbial/parasitic diseases-causing agents;
2) Government and non-governmental agencies should endeavor to make pipe-borne water available to rural communities due to its high level of parasitological and microbial safety as revealed in this research;
3) Ministries of water resources and environment of states and federal levels should take the following steps: organize sensitization programmes addressing waterborne diseases, work closely with world health organization (WHO) and other health bodies to provide direct necessary support to Nigerian government so as to mitigate unsafe drinking water and waterborne diseases in Nigeria;

4) People should as well cultivate the habit of boiling or treating water meant for consumption to reduce the chances of disease transmission.

In the opinions of this authors, other counties in the world with this “Open Defecation” problems can emulate this nice and recommendable roadmap developed by Nigeria.

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