

CLINICAL REVIEW

# Incidence of Diarrhoea and Predisposing Factors Among Under-Five Children in Nigeria: Critical Review

Evurani Somtochukwu Amuche<sup>1\*</sup>, Omo-Omorodion Blessing Itohan<sup>2</sup>, Attama Amaechi Attama<sup>3</sup>,  
Ugwu Chinenye Nnenna<sup>1</sup> and Ibezim Emmanuel Chinedu<sup>2</sup>

<sup>1</sup>*Department of Pharmaceutical Microbiology and Biotechnology, University of Nigeria, Nsukka, Nigeria*

<sup>2</sup>*Department of Microbiology, Edo State University Uzairue, Edo State, Nigeria*

<sup>3</sup>*Department of Pharmaceutics, University of Nigeria Nsukka, Nigeria*

Correspondence should be addressed to Evurani Somtochukwu Amuche, Department of Pharmaceutical Microbiology and Biotechnology, University of Nigeria, Nsukka, Nigeria

Received: 10 June 2022; Accepted: 01 July 2022; Published: 08 July 2022

Copyright © Evurani Somtochukwu Amuche. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## **ABSTRACT**

Diarrhoea is a form of gastrointestinal infection caused by diarrhoeagenic bacteria, viruses or parasites ingested as a result of contaminated food or water. In Nigeria, diarrhoea is the second killer disease in under-five children after malaria with a national prevalence rate of 18.8% making it a menace in sub-Saharan Africa. It is estimated that at least 150,000 children die yearly in Nigeria due to diarrhoea attack; and every child under five years experiences at least five episodes of diarrhoea per annum. This critical review examined diarrhoea incidences and determinant factors among under-five children in Nigeria. Relevant literature materials were sourced from Google Scholar and PubMed using 'diarrhoea incidence in Nigeria', or 'diarrhoea determinant factors' as Medline keywords and only data between 2015 and 2021 were included. Papers were collected and after Abstract screening, papers that met the criteria were selected for the study.

The study concludes that Nigeria as a developing Nation has high diarrhoea prevalence rate of between 18.8% to 31.8% with more incidences occurring in northern Nigeria than in southern Nigeria. The discrepancies in the geometric distribution of disease were attributable to some determinant factors such as high poverty level, educational status, poor environmental sanitation, religion, poor hygiene and hand washing practice which indirectly impact on child's health. The review observed that the determinant factors were more emphasized than the etiological factors; suggesting that if determinant factors were adequately addressed, the agents will be significantly reduced. It is in the desire of this review that millions of children at risk of death from diarrhoea are saved by proper and meticulous application of the preventive and treatment measures.

## **KEYWORDS**

Diarrhoea, Incidences, Prevalence, Determinant factors, Nigeria

## **INTRODUCTION**

The World Health Organization (WHO) defined diarrhoea as the passage of loose or watery stools at least three times per day, or the passage of stools more often than normal by an individual [1]. However, it must be underscored that, frequent passing of formed stools is not diarrhoea [2]. For example, babies who are fed on breast milk often pass loose or watery stools and therefore, cannot be described as diarrhoea [3]. What makes a condition diarrhoea is the presence of the pathogens or causative agents which stimulate the gastro-intestinal tract to frequently empty the content. The pathogens which cause diarrhoea in human are often found in faecal matter. The organisms are then transmitted from the stool of an infected person to the mouth of another person via contaminated water, food, hands, eating and drinking utensils, flies, and dirt under fingernails, a process known as faecal-oral transmission.

Diarrhoea is also a major cause of malnutrition in under-five children because nutrients are poorly absorbed and appetite is lost. Recurrent attacks of diarrhoea significantly weaken the child with each episode moving the child further away from his/her normal weight, homeostatic balance and predisposing the child to malnutrition and impaired development.

About 2.5 billion cases of diarrhoea occur in under-five children each year. These values have remained relatively stable over the past three decades; with over 50% of the cases occurring in Africa and South Asia where episodes of diarrhoea may likely result in severe morbidity and death [3]. The WHO reported that diarrhoea is responsible for 8.5% and 7.7% deaths in Africa and South Asia. Every child in Africa was estimated to have at least five bouts of diarrhoea per year in which 800,000 persons die out of the crisis. In 2008, five countries of the developing world (India, Nigeria, Congo, Pakistan and China) contributed half of the total deaths caused by diarrhoea among 4.249 million children [4].

In Nigeria, diarrhoea is the second leading cause of death in under-five children (after malaria) with a prevalence rate of 18.8% making it one of the worst diseases in sub-Saharan Africa. In 2009, the WHO reported that Nigeria records at least 151700 child's death per year (WHO). Such high incidences of diarrhoea might be associated with poor hygiene, standard of living, poverty, illiteracy, ingestion of contaminated water and foods [5]. The diarrheal pathogens are ubiquitously present or may be sporadically introduced into the food chains all over the world. However, studies have shown that what is common in developing countries (Africa) is very rare in developed countries where high levels of personal and domestic hygiene are enforced. That is, diarrhoea is very uncommon in developed worlds because they practice proper hygiene system and have good access to safe portable water. This suggests that the disease condition can be successfully controlled through the practice of personal, domestic and environmental hygiene and disinfecting of surfaces including conscious practicing of hand wash, etc. Occurrence of diarrhoea is highest within the first 2-years of life and declines with age. Within this age period, children with impaired immunity or who suffer malnourishment may experience life-threatening crisis resulting from diarrhoea [3].

Diarrhoea was listed as one of the three most prevalent waterborne diseases in southwest Nigeria after typhoid fever and cholera. Also, the molecular epidemiology of diarrheal pathogens, anti-diarrheal activities of indigenous medicinal plants, and the risk factors of childhood diarrhoea have been highlighted [6]. There seems to be uneven distribution or existence of discrepancy in the epidemiology of diarrhoea in Nigeria with more incidences occurring in northern Nigeria than in the southern Nigeria [3,7]. In northern Nigeria, the prevalence and determinants of diarrhoea among infants in primary health centres in Kaduna have been reported in which the authors highlighted proper hygiene, nutrition education for nursing mothers, meticulous hand washing practices and child immunization as pre-requisites in disease burden reduction [3].

Diarrhoea has also been shown to attract socio-economic burdens and also poses immediate threat to child's well-being and participation in social-economic activities of his environment. Some of the chronic effects of diarrhoea on child's development in the first two years of lives include growth deficits, physical fitness impairment, cognitive deficit and underperformance in school. Economically, billions of dollars are spent annually in the fight against the disease pathogens. Diarrhoea, therefore, impacts key areas of national development such as health, economy and education.

### **ETIOLOGIC AGENTS OF DIARRHOEA AND CLASSIFICATION**

Etiologically, diarrhoea is generally classified into acute or chronic based on its causative agents [8]. Acute diarrhoea also known as acute watery diarrhoea is primarily caused by infectious agents such as rotavirus, enterotoxigenic *Escherichia coli*, *Shigella spp*, *Campylobacter jejuni*, and *Cryptosporidium spp*. Chronic diarrhoea, in contrast, is basically caused by non-infectious agents such as inherited metabolic disorders, gluten or tumor growth (neoplasm) [9]. Consequently, diarrhoea may be classified on the basis of duration, pathophysiology and etiological agents. In terms of duration, diarrhoea can be acute, persistent or chronic. Acute diarrhoea is characterised by sudden onset of watery stool that may last for 14 days or less. The watery discharge may be accompanied by fever and vomiting. Persistent diarrhoea begins as acute diarrhoea and lasts for 14 days or more but not more than 28 days. Chronic diarrhoea starts as deceptively and lasts longer than 28 days; it may be recurring or continuous [1,8].

On the basis of pathophysiological mechanism, diarrhoea may be secretory, osmotic, inflammatory or impaired stomach motility. Secretory diarrhoea is said to occur when there is active secretion of water into the intestinal lumen as a result of intracellular accumulation of cyclic adenosine monophosphate (cAMP) or cyclic guanosine monophosphate (cGMP). These secondary messengers are stimulated by secretagogue or toxin bound to a receptor on the surface epithelium of the bowel. The toxin may be infectious or non-infectious making secretory diarrhoea infectious or non-infectious.

Osmotic diarrhoea (OD) however, occurs when an individual consumes a poorly absorbed substance such as magnesium, phosphate, lactulose, and sorbitol, as in the case of lactase deficiency syndrome (LDS) in which lactose is not absorbed. Therefore, the major cause of OD is malabsorption after intake of certain food substance. OD is also experienced when an individual is infected by rotavirus; in such case, glucose is not well absorbed. Inflammatory diarrhoea (ID) occurs as a result of intestinal inflammation which results in loss of fluids and

electrolytes into the intestinal lumen. ID is caused by inflammatory bowel disease, celiac disease, tuberculosis, and colon cancer which are chronic conditions (WHO).

On the basis of etiology, diarrhoea is classified as infectious or non-infectious with the former being more common than the latter. Virus, bacteria, parasites or fungi mediate infectious diarrhoea while underlying clinical conditions such as systemic diseases and congenital disorders mediate non-infectious diarrhoea [8,10].

## **EPIDEMIOLOGY**

The diarrheal pathogen is transmitted via faecal-oral transmission as the organism is known to live in faecal matters [10]. In Nigeria, where every under-five child experiences at least 3 hours to 4 bouts of diarrhoea per year, the incidences vary greatly with seasons and age of a child. Youngest children are most vulnerable to diarrhoea with incidence highest in the first two years of life and declines as the child grows older [11].

The WHO reported 1.7 billion cases of diarrhoea every year in under-five children thereby making diarrhoea the second-leading cause of death in under-five with 760,000 death per year. Diarrhoea kills more children than AIDS, malaria and measles combined; diarrhoea is a leading cause of malnutrition and stunting in children. Mortality from diarrhoea has over the past two decades from an estimated 5 million deaths among children fewer than five to 1.5 million deaths in 2004 because of WHO interventions to promote national policies and investments that supports case management of diarrhea and its complication , conduct new research to test new diarrhea prevention and the control strategies and to train health workers especially at the community level, despite these declines, diarrhoea remains the second most common cause of death among children under five globally [11].

The major risk factors associated with childhood diarrhoea include poor breastfeeding habit, ingestion of faecal matter contaminated food and water, poor food storage system, poor hand hygiene in child and caregiver, malnutrition, etc. Also, presence of ongoing disease conditions such HIV and measles also contributes to diarrhoea in children. Poor healthcare system, illiteracy among nursing mother, low maternal age who rarely understands disease prevention, poverty and lack of health information have also been implicated in diarrhoea morbidity [11].

Rotavirus is the predominant cause of diarrhoea in under-two children in developed countries with highest incidence rate occurring between 6 months - 18 months of life. Diarrhoea epidemics caused by viruses often occur in institutions like daycare centres, elderly homes, etc. Viruses are resistant to common disinfectants, temperature, and physical forces. However, ethanol has been found to completely inactivate diarrhoeagenic virus hence, its use (79% ethanol) to clean environmental surfaces and eliminate viruses [11]. The African center for disease control CDC (2014) placed the Nigeria mortality rate from various diseases as follow: Malaria (20%), diarrhoea (15%), lower respiratory infections (9%), HIV (9%), road injuries (5%), protein energy malnutrition (4%), cancer (4%), meningitis (3%), stroke (4%), tuberculosis (4%) [11]. Thus, according to the African center for disease control CDC (2014), diarrhoea is the second largest killer disease in Nigeria after malaria, Diarrhoea remains a major public health problem especially in developing countries where it is a leading cause of childhood morbidity and mortality.

## **INFECTIOUS PATHOGENS FOR ACUTE WATERY DIARRHOEA**

Acute watery diarrhoea is caused by viruses, bacteria, parasites or fungi. Bacterial organisms with known diarrheal history are mainly of *Escherichia coli* origin. Examples of diarrhoeagenic *E. coli* are entero-pathogenic *E. coli*, entero-invasive *E. coli*, verocytotoxin-producing *E. coli*, entero-aggregative *E. coli*, entero-toxigenic *E. coli*, and attaching and effacing *E. coli*. Other diarrhoeagenic bacterial species include *Shigella species*, *Salmonella species*, *vibrio cholerae*, *Campylobacter jejuni/coli*, *Yersinia enterocolitica*. Examples of *Salmonella* species are *S. typhimurium*, *S. enterica*, *S. infantis*, *S. anatum*, *S. newport* and *S. ohio*. *Shigella* species include *Shigella flexneri*, *Shigella sonnei*, and *S. boydii*. Diarrhoeagenic *E. coli* and *Shigella spp* show high level of resistance to ampicillin, chloramphenicol, trimethoprim/ sulfamethoxazole [8].

More so, diarrhoeagenic virus include rotavirus, astrovirus, enteric adenovirus (adenovirus type 40 and 41), Norovirus, Sapovirus and Coronavirus. Fungal agents of diarrhoea include *Candida albicans*, *C. krusei*, *C. albicans*, *C. tropicalis*, *C. pseudotropicalis*, *C. globrata*, *C. parapsilosis* [12].

Diarrhoeagenic parasites include *E. histolytica*, *E. dispar*, *Giardia lamblia* or *G. intestinalis*, *Trichomonas intestinalis*, *Cryptosporidium species*, *Dientamoebafragilis*, *Trichuristrichiura*, *Hymenolepisnana*, *Strongyloidesstercoralis*, *Ascarislumbricoides* [13].

## **THE DEATH SENTENCE OF DIARRHOEA**

The major cause of death in acute watery diarrhoea is dehydration and malnutrition. Dehydration occurs as a result of frequent passage of watery stools and emptying of stomach contents. Malnutrition occurs as a result of loss of appetite, reduced feeding, inability to absorb and utilize nutrient molecules during the diarrheic phase. Consequently, prolonged episodes of acute watery diarrhoea have adverse impact on growth.

## **PREVALENCE OF UNDER-FIVE DIARRHOEA AND ITS CONTEXTUAL DETERMINANTS**

Magbagbeola et al. (2017) [3] studied the prevalence and determinants of diarrhoea among infants in Kaduna north primary health centres, Nigeria and observed that 57.5% of the infants had experienced diarrhoea at least once at different points in time with a prevalence rate of 21.1%. The authors observed that infants under the age of 6 months had a higher diarrhoea episode (71.7%) than infants who were above 6 months (28.3%); with most cases occurring between 3 months - 4 months of life. The respondents maintained that most diarrhoea episodes (78.4%) were treated at the hospital while a few (16.7%) were treated at home. The major determinant factors which the authored highlighted include poor practice of hand wash with soap after cleaning infant's perineum, incomplete child immunization, incomplete breastfeeding or non-exclusive or mixed feeding, poor knowledge of diarrhoea by mothers or caregivers.

In Enugu southeast Nigeria, Ugochukwu et al. (2020) [14] determined the prevalence of diarrhoea and assessed the water, sanitation and hygiene risk factors for diarrhoeal disease in a rural community and observed 10.77% prevalence rate in under-five children as against 7.49% in older children. The authors observed that the overall prevalence of diarrhoea in under-five children in Enugu was significantly lower than 21% reported in some sub-Saharan African countries [15]; but similar to the prevalence rates of 6.4% and 7.6% reported from some developed countries [16]. The study concluded that the prevalence of diarrhoea was higher among children

younger than five years in Enugu while incriminating use of public toilets, poor handwashing habit as predisposing factors [14].

The prevalence of diarrhoea and its associated risk factors in children aged 0 year - 5 years in Umuahia, Abia State, Nigeria has been reported [17]. Authors highlighted impacts of seasonal variations in the distribution of diarrhoea with highest cases (22%) recorded in the month of January. They found a steady decline between April and June when compared to other months and attributed the changes to transitional period between rainy and dry seasons [15]. The study attributed the reduction in diarrhoea cases in Umuahia, Abia State to high literacy level, income level, cleaner environments, good hygiene levels, etc.

In southwest Nigeria, the risk factors of diarrhoea among under five children have also been evaluated in Ogun State [6]. Mother's education, employment, and family income were major determinants factors for childhood diarrhoea in southwest Nigeria. Their findings showed that a child from a poor family is more likely to have diarrhoea than a child from a rich home. This correlated well with Mesagan and Adeniji-Ilori (2018) [18] who also observed that low socioeconomic status encumbers the health of under five children in Southwest Nigeria. They argued that reduced income would likely subject a family to poor living conditions in which they cannot afford potable drinking water, proper sewage disposal, drainage system, good toilet facilities which are risk factors for childhood diarrhoea [19].

## **TREATMENT OF DIARRHOEA**

Till date the best treatment option for diarrhoea is oral rehydration therapy (ORT) which was pioneered by the International Centre for Diarrheal Disease Research, Bangladesh. The treatment package focuses on two main elements, namely fluid replacement and zinc treatment [11].

### ***Oral Rehydration Therapy (ORT)***

ORT is comprised of sodium, glucose, potassium, chloride, and alkali (bicarbonate or citrate) in specific concentrations in clean water [20]. According to the WHO formula, ORT is effective for every kind of dehydration with success records in reducing child's mortality [21]. ORS-WHO is an effective therapeutic tool with over two billion ORS units administered without serious complications. The use of symptomatic antidiarrheal drugs and antimicrobial drugs in uncomplicated diarrhoea crises is discouraged. In contrast, antimicrobials are recommended for treatments of dysentery, cholera, typhoid fever and diarrhoea caused by parasites, such as *Giardia lamblia*, *Cyclospora spp* and *E. histolytica* [11].

### ***Homemade Fluids (HMF)***

HMF is a cheap alternative for ORS if the latter is not available. In Nigeria, HMF is a mixture of salt and sugar in water in what proportion. HMF is also effective in preventing dehydration in children with diarrhoea, even though they are not as effective in treating children who have become dehydrated [22].

### ***Probiotics***

These are microorganisms which provide health benefits when consumed. Consumptions of probiotics are considered to be generally safe to humans but may cause bacteria-host interactions mostly strains of lactobacillus spp. Probiotics improve intestinal-microbial balance by creating unfavourable environment through the

production of antimicrobials and thereby compete with pathogens for essential nutrients and binding sites in the intestinal mucosa for the metabolism of nutrients and bile acids [23,24].

### **Zinc Treatment**

Zinc is critical for complete health, growth and development. In addition, it supports proper functioning of the immune system [25]. It is widely found in protein-rich food sources. Zinc deficiency is associated with higher rates of infectious diseases, including diarrhoea, and deaths. Zinc supplementation is critical for replenishing the body's reserves which helps the affected children to recover from illness and stay healthy afterwards. Children who receive zinc therapy earlier show low incidence, frequency and persistence of diarrhoeal illnesses. Zinc also increases ORS uptake and reduces inappropriate drug use with antibiotics and anti-diarrheal medications. Children who received zinc tablets were reported to recover more quickly, with increased strength and vitality. They were also less ill than other children who didn't receive zinc therapy [11].

### **PREVENTION OF CHILDHOOD DIARRHOEA**

The diarrheal pathogen is transmitted via faecal-oral transmission [10]. In Nigeria, preventive measures are still not efficiently dispensed owing to social, cultural, religious and economic frictions in the country. The Government is rising up to addressing the challenge especially in the Northern Nigeria with high records of diarrheal-related deaths owing to poor hygiene practice, religion and high illiteracy level in the area. Access to clean potable water, hygiene and good sanitation practice is shown to decrease diarrhoea morbidity and mortality by 26% and 65%, respectively.

Author	Study Location	Study Center	Incidence Rate %	Prevalence Rate %	Vulnerable Rate	Determinants/Predisposing Fraction	Seasonal Variation
<i>Ugboko et al. [14]</i>							
<i>Raji MI and Ibrahim YKE 2011 [26]</i>	Sokoto Northwest Nigeria	Primary Health Care	29.34	5.0	0<5 Years	Water Borne Infection	
<i>Felix Akpojeneogbo 2019</i>		Public Health	33.3	16.9	0<5	Sub-optimal Breastfeeding	
<i>MKJ Jinadu et al. 1991</i>	Akoko North Ondo State	Home and Health Center	62.1	8.1	0<5	Poor Hygiene	
<i>Mathew AK 2019</i>	Kaduna Anaorth-West	Public Health		31.7	0<6	Poor Feeding and Poor Breast Feeding (Exclusive)	
<i>Joseph et al. 2017 [8]</i>	Ekiti	Health Care Center		18.8			
<i>Akinrotaye et al. 2018 [11]</i>	Ogun State	Public Health		18.8	0<11 Month	Lack of Education to the Mothers	
<i>Sanni Yaya 2018 [19]</i>	Abuja	Health Center	NA	11.3	0<5	Access to Improved Toilet and Drinking Water	
<i>Magbagbeola et al. (2017) [3]</i>	Kaduna Northern Nigeria	Primary Health Centre	57.5	21.1	3-4 Months	Poor Hygiene Incomplete Immunization No Exclusive Bbreastfeeding	NA
<i>Ugochukwu et al. (2020) [14]</i>	Enugu Southeast	Rural Community	NA	10.77	<5 Years Old	Public Toilet Poor Hand Washing	NA
<i>Nwaoha et al. 2017 [17]</i>	Umuahia Southeast Nigeria	NA	NA	NA	<5 Years Old	Poor Hygiene Education Status Financial Status	Yes
<i>Harriet et al. 2021 [6]</i>	Ogun State Southwestern Nigeria	NA	NA	NA	NA	Maternal Education Level Employment Family Income	NA

**Table 1:** Detailed information about authors and study details.

Consequently, the WHO introduced three key preventive elements by the acronym ‘WASH’ standing for water, sanitation and hygiene. Other preventive measures were later introduced and include vaccination against rotavirus, exclusive breastfeeding, vitamin A supplementation; regular hand washing practice and sanitation [11] (Figure 1 and Figure 2).

Author(s) of Publication	Scientific Name	Common Name	Vernacular Name	Family	Study Location	Geographical Source	Morphological Part
Babu DSR <i>et al.</i> 2009 [27]	<i>Cynodon dactylon</i>	Bermuda grass	Grama brava (Spanish)	Poaceae	India	Europe	Leaves and Stem
Daniel Dahiru <i>et al.</i> 2009 [28]	<i>Ziziphus mauritiana</i>	Indian Jujube	Jujube (Yoruba)	Rhamnaceae	Nigeria	India	Roots
Havagiray R Chitme <i>et al.</i> 2004 [29]	<i>Calotropis gigantea</i>	Giant Calotrope	Niu jiao gua (Chinese)	Apocynaceae	India	Cambodia	Roots, Bark and Leaves
Qnais EY <i>et al.</i> 2007 [30]	<i>Punica granatum</i>	Pomegranate	Osisi pomegranet (Igbo)	Lythraceae	Australia	Spain	Seeds
Venkatesan N <i>et al.</i> 2005 [31]	<i>Asparagus racemosus</i>	Shatavari	Aluki (Yoruba)	Asparagaceae	India (Hisar)	Europe	Roots
Uddin S <i>et al.</i> 2005	<i>Xylocarpus moluccensis</i>	Nyireh Batu	Nyireh batu (Singapore)	Meliaceae	India	Singapore	Bark and Fruit
John AO <i>et al.</i> 2008 [32]	<i>Psidium guajava</i>	Guava	Gova (Igbo)	Myrtaceae	South Africa	Nigeria	Leaf
Yasmeen Maniyar <i>et al.</i> 2010 [33]	<i>Ixora coccinea L.</i>	Jungle geranium	Viruchi (Hindi)	Rubiaceae	India	Southern India	Flowers
Razina Rouf <i>et al.</i> 2007 [26]	<i>Xylocarpus granatum</i>	Cedar mangrove	Xuong ca (Vietnamese)	Meliaceae	India	Philippines	Bark
Ankita Misra 2013	<i>Moringa oleifera</i>	Moringa	Ewe igbale (Yoruba)	Moringaceae	India	India	Leaf
Yakubu MT <i>et al.</i> 2015 [34]	<i>Magnifera indica</i>	Mango	Mangoro (Igbo)	Anacardiaceae	Nigeria (Ilorin)	Nigeria	Seeds
Das A. <i>et al.</i> 2008 [35]	<i>Rhizophora mucronata</i>	Red Mangrove		Rhizophoraceae	India	Puerto Rico	Bark
Khalid Md S <i>et al.</i> 2011 [36]	<i>Mimosa pudica</i>	Shameplant	Laajvanti (Hindi)	Fabiaceae	India (Uttar Pradesh)	Barbados	Roots and Leaves
Shamkuwar PM <i>et al.</i> 2012 [37]	<i>Piper nigrum L.</i>	Black pepper	Uziza (Igbo)	Piperaceae	India	Nigeria	Fruit
Poonam G <i>et al.</i> 2011 [38]	<i>Cyperus rotundus</i>	Nut grass	Ciyawa goro (Hausa)	Cyperaceae	India	Kenya	Roots
Talukder MJ <i>et al.</i> 1998 [39]	<i>Nelumbo nucifera</i>	Indian lotus	Lotos (Latin)	Nelumbonaceae	Bangladesh	India	Rhizome
Afroz S <i>et al.</i> 2006 [40]	<i>Paederia foetida L.</i>	Stinkvine	Gandali (Malawi)	Rubiaceae	Bangladesh	China	Roots and Leaves

**Table 2:** Herbal plants used in the management of diarrhea.

## **CONCLUSION**

In conclusion, there appears to be high (18.8%) and uneven distribution in the prevalence of diarrhoea in Nigeria with more incidences occurring in northern Nigeria than in southern Nigeria. The determinant factors of diarrhoea in the country were identified to be high poverty level, lack of education, poor environmental sanitation, religion, poor hygiene and hand washing practice which indirectly impact on child’s health. The study observed that the determinant factors were more emphasized than the etiological agents; suggesting that if those factors were adequately handled, the agents will be significantly reduced.

## **CONSENT FOR PUBLICATION**

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

## **COMPETING INTERESTS**

The authors declare that they have no competing interest.

## **REFERENCES**

1. World Health Organization (2005) The treatment of diarrhoea. A manual for physicians and other senior health workers.
2. Black RE and Lanata CF (2002) Epidemiology of diarrheal diseases in developing countries, in *Infections of the Gastrointestinal Tract*, 2<sup>nd</sup> (Edn.) Ravdin HB, Greenberg, (Eds.) Philadelphia, Lippincott, Williams, and Wilkins.
3. Dairo MD, Ibrahim TF, Salawu AT (2017) Prevalence and determinants of diarrhoea among infants in selected primary health centres in Kaduna north local government area, Nigeria. *Pan African Medical Journal* 28(1): 151-151.
4. Ghosh K, Chakraborty AS, Mog M (2021) Prevalence of diarrhoea among under five children in India and its contextual determinants: A geo-spatial analysis. *Clinical Epidemiology and Global Health* 12: 100813.
5. Raji MIO and Ibrahim YKE (2011) Prevalence of waterborne infections in Northwest Nigeria: A retrospective study. *Journal of Public Health and Epidemiology* 3(8): 382-385.
6. Ugboko HU, Nwinyi OC, Oranusi SU et al. (2021) Risk factors of diarrhoea among children under five years in southwest Nigeria. *International Journal of Microbiology*: 1-9.
7. Matthew AK, Amodu AD, Sani I et al. (2009) Infant feeding practices and nutritional status of children in North Western Nigeria. *Asian Journal of Clinical Nutrition* 1(1): 12-22.
8. Joseph AA, Odimayo MS, Oluwayemi IO et al. (2017) An overview of the aetiologic agents of diarrhoea diseases in children: How far have we gone in management and control?. *Medical Journal of Zambia* 44(4): 266-275.
9. Odimayo MS, Fowotade TA, Adegboro B (2011) Opinion of care givers on the possible cause of Diarrhea among children in Ilorin, Nigeria. *Pioneer Medical Journal* 1(2): 10-13.
10. Nguyen TV, Le Van P, Le Huy C et al. (2006) Etiology and epidemiology of diarrhea in children in Hanoi, Vietnam. *International Journal of Infectious Diseases* 10(4): 298-308.
11. Peter AK and Umar U (2018) Combating diarrhoea in Nigeria: The way forward. *Journal of Microbiology and Experimentation* 6(4): 191-197.
12. Imade PE and Eghafona NO (2015) Viral and fungal diarrhea in children under 5 years of age in a tertiary health institution in Edo State, Nigeria. *American Journal of Infectious Diseases and Microbiology* 32: 87-90.
13. Fodha I, Chouikha A, Peenze I et al. (2006) Identification of viral agents causing diarrhea among children in the Eastern Center of Tunisia. *Journal of Medical Virology* 78(9): 1198-1203.

14. Nwokoro UU, Ugwa O, Onwuliri CD et al. (2020) Water, sanitation and hygiene risk factors associated with diarrhoea morbidity in a rural community of Enugu, South East Nigeria. *The Pan African Medical Journal* 37(115).
15. Tumwine JK, Thompson J, Katua-Katua M et al. (2002) Diarrhoea and effects of different water sources, sanitation and hygiene behaviour in East Africa. *Tropical Medicine & International Health* 7(9): 750-756.
16. Scallan E, Majowicz SE, Hall G et al. (2005) Prevalence of diarrhoea in the community in Australia, Canada, Ireland, and the United States. *International Journal of Epidemiology* 34(2): 454-460.
17. Florence Nwaoha A, Chima Ohaeri C, Charles Amaechi E (2017) Prevalence of diarrhoea, and associated risk factors, in children aged 0-5 years, at two hospitals in Umuahia, Abia, Nigeria. *Cuadernos de Investigación UNED* 9(1): 7-14.
18. Mesagan PE and Adeniji-Ilori OM (2018) Household environmental factors and childhood morbidity in South-western Nigeria. *Fudan Journal of the Humanities and Social Sciences* 11(3): 411-425.
19. Yaya S, Hudani A, Udenigwe O et al. (2018) Improving water, sanitation and hygiene practices, and housing quality to prevent diarrhea among under-five children in Nigeria. *Tropical Medicine and Infectious Disease* 3(2): 41.
20. Pierce NF (2001) How much has ORT reduced child mortality?. *Journal of Health, Population and Nutrition*: 1-3.
21. Warren PB (2003) Diarrhea in childhood. Department of pediatrics. The University of Iowa, USA.
22. Fontaine O, Gore SM, Pierce NF (1998) Rice-based oral rehydration solution for treating diarrhoea. *Cochrane Database of Systematic Reviews* (4): CD001264.
23. Isolauri E (2001) Probiotics in human disease. *The American Journal of Clinical Nutrition* 73(6): 1142S-1146S.
24. Akinrotoyee KP (2014) Effects of fermented palm wine on some diarrhoeagenic bacteria. *Elite Research Journal of Biotechnology and Microbiology* 2(1): 4-14.
25. Bhandari N, Mazumder S, Taneja S et al. (2008) Effectiveness of zinc supplementation plus oral rehydration salts compared with oral rehydration salts alone as a treatment for acute diarrhea in a primary care setting: A cluster randomized trial. *Pediatrics* 121(5): e1279-e1285.
26. Rouf R, Uddin SJ, Shilpi JA et al. (2007) Assessment of antidiarrhoeal activity of the methanol extract of *Xylocarpus granatum* bark in mice model. *Journal of Ethnopharmacology*, 109(3): 539-542.
27. Babu DR, Neeharika V, Pallavi V et al. (2009) Antidiarrheal activity of *Cynodon Dactylon. pers.* *Pharmacognosy Magazine* 5(19): 23.
28. Dahiru D, Sini JM, John-Africa L (2006) Antidiarrhoeal activity of *Ziziphus mauritiana* root extract in rodents. *African Journal of Biotechnology* 5(10).
29. Chitme HR, Chandra R, Kaushik S (2004) Studies on anti-diarrhoeal activity of *Calotropis gigantea* R. Br. in experimental animals. *Journal of Pharmacy and Pharmaceutical Sciences* 7(1): 70-75.
30. Qnais EY, Elokda AS, Abu Ghalyun YY et al. (2007) Antidiarrheal activity of the aqueous extract of *Punica granatum* (Pomegranate) peels. *Pharmaceutical Biology* 45(9): 715-720.
31. Venkatesan N, Thiyagarajan V, Narayanan S et al. (2005) Anti-diarrhoeal potential of *Asparagus racemosus* wild root extracts in laboratory animals. *Journal of Pharmacy and Pharmaceutical Sciences* 8(1): 39-46.

32. Ojewole JA, Awe EO, Chiwororo WD (2008) Antidiarrhoeal activity of *Psidium guajava* Linn. (Myrtaceae) leaf aqueous extract in rodents. *Journal of Smooth Muscle Research* 44(6): 195-207.
33. Maniyar Y, Bhixavatimath P, Agashikar NV (2010) Antidiarrheal activity of flowers of *Ixora Coccinea* Linn. in rats. *Journal of Ayurveda and Integrative Medicine* 1(4): 287.
34. Yakubu MT and Salimon SS (2015) Antidiarrhoeal activity of aqueous extract of *Mangifera indica* L. leaves in female albino rats. *Journal of Ethnopharmacology* 163: 135-141.
35. Das AK, Rohini R, Hema A (2009) Evaluation of anti-diarrhea activity of *Rhizophora mucronata* bark extracts. *The Internet Journal of Alternative Medicine* 7(1): 1-9.
36. Khalid MS, Kumar SJ, Suresh DK et al. (2011) Evaluation of anti-diarrhoeal potential of ethanolic extract of *Mimosa pudica* leaves. *International Journal of Green Pharmacy (IJGP)* 5(1).
37. Shamkuwar PB, Shahi SR, Jadhav ST (2012) Evaluation of antidiarrhoeal effect of Black pepper (*Piper nigrum* L.). *Asian Journal of Plant Science and Research* 2(1): 48-53.
38. Daswani PG, Brijesh S, Tetali P et al. (2011) Studies on the activity of *Cyperus rotundus* Linn. tubers against infectious diarrhea. *Indian Journal of Pharmacology* 43(3): 340.
39. Talukder MJ and Nessa J (1998) Effect of *Nelumbo nucifera* rhizome extract on the gastrointestinal tract of rat. *Bangladesh Medical Research Council Bulletin* 24(1): 6-9.
40. Afroz S, Alamgir M, Khan MTH et al. (2006) Antidiarrhoeal activity of the ethanol extract of *Paederia foetida* Linn. (Rubiaceae). *Journal of Ethnopharmacology* 105(1-2): 125-130.