

Original Article

Recreational Water Use and Health Insecurity among Children: The Case of Manyera River, Niger State, Nigeria.

Musediq Olufemi Lawal¹, Timileyin Gabriel Olajuwon²

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¹ Osun State University 1 Nigeria; flawal2005@gmail.com
² University of Western Cape South Africa; 4284200@myuwc.ac.za
* Correspondence: flawal2005@gmail.com 4284200@myuwc.ac.za +2348034455856

Abstract: *Water recreation in contaminated environments poses serious health hazards, especially for vulnerable groups such as children. This study examines the environmental risk of heavy metal exposure for children who participate in water recreation activities in the Manyera River, Niger State, Nigeria. The Manyera River, having undergone different anthropogenic human activities, has been identified as a potential source of toxic heavy metals such as lead, mercury, and cadmium. The study employed questionnaire and in-depth interview plus non-participant observation and library search to source for its data. The results revealed an increased artisanal mining and unsustainable methods posed substantial threats, particularly to community members and children who frequently utilized the river for domestic and recreational activities. Children were more exposed to heavy metals, such as mercury, which is found in concentrations higher than the W.H.O. safe limit (0.006mg/L). This exposure offers substantial health insecurity to children, potentially affecting their respiratory, cognitive, and cardiovascular systems and increasing their chances of developing cancer in the future. The study emphasizes the urgent need for public health interventions, environmental remediation, and legislative changes to safeguard children from the long-term effects of exposure. Addressing these concerns is critical for protecting children's health and creating safer recreational areas.*

Keywords: Water recreation, Heavy metal exposure, Health insecurity, Environmental risk.

1. Introduction

Throughout history, water has had a significant role in determining the type, frequency, and intensity of leisure activities in different places. There is a persistent and complex relationship between water resources and human behaviour in an environment, which is highlighted by looking at past recreation patterns and making predictions about future trends in recreational use [1, 2, 3]. The significance of water cannot be underemphasized as it enhances recreational activities, which include, but are not limited to, hiking, and camping along bodies of water, viewing scenery, and studying nature. The presence of water contributes to many recreational opportunities, including both water-based and water-enhanced recreational activities. Although water-based and water-enhanced recreational activities are often less detrimental to water quantity and quality, many human uses of water (e.g., agriculture, industry, etc) nonetheless have greater effects. However, while the impact of recreation on the water regime still presents challenges to managers attempting to create opportunities for recreational activities, maintaining water and environmental quality seems difficult.

In general, anthropogenic activities are often identified as the main sources of pollution, whereas the public perception of water pollution, for example, depends on the visibility and the presence of algae and turbidity in the water. This perception plays a crucial role in decisions regarding the use of water. For instance, the transparency of water is an important consideration to assess the viability of a water location, and for it to be considered for swimming or other recreational activities. This is because, when the water is clear, there is confidence that the water is safe for drinking, swimming, and more, despite the fact that there may be specific toxic compounds present in it. On the flip, if water appears polluted, even if it is not, people are unlikely to engage in recreational activities in the water body. Unfortunately, despite the perception, the presence of chemicals and pathogens in water often poses a significant threat to the health of those who use it for recreation, especially children who are most vulnerable to waterborne pathogens and contaminants due to their developing immune systems, frequent hand-to-mouth behaviors, and prolonged exposure during play [4].

While there has been significant analysis of water's benefits, especially for recreational activities, the health risks posed by poor-quality recreational water cannot be left unattended. In both coastal and freshwater, the point sources of pollution that cause the most health concern are those due to domestic sewage to coastal and riverine waters, which exert a variable polluting effect that depends on the quality and composition of the effluent and the capacity of the receiving waters to accept that effluent. Prolonged exposure to these toxins can cause health problems in children who swim and play in the water, such as skin irritations, respiratory troubles, and, in severe cases, neurological and developmental impairments [4, 5]. Additionally, pollution in recreational waterways can cause a variety of ailments, including gastrointestinal infections, skin concerns, and respiratory problems [6]. Therefore, to effectively manage water-based recreation, integrated approaches that consider both social and environmental factors are required. This entails balancing human enjoyment with the requirement to maintain the environmental condition of water bodies.

The health implications of unsafe recreational water use are a public health concern. However, relatively little is known about the attitude of the local communities to water-based recreation activities, their knowledge of possible health hazards in water recreation, and other behavioural approaches to these activities and the noted hazards. This study, therefore, becomes necessary to fill the vacuum thus created through a study of the attitude of the people towards water-based recreation using the Manyera River, in Niger State, as the focus of the study. To address this issue, the following questions were raised: What are the likely and manifesting health hazards that are associated with the usage of the water in these rivers? How are the noted health hazards being treated? What are the social and medical implications of the noted hazards in the host communities? A study of this nature has the potential to bring to the limelight what people undergo while using unregulated water for recreation. Students, scholars, researchers, health care managers, and others could find this study useful as it will broaden their knowledge and will equally contribute to the existing literature on tourism, recreation, and health in Nigeria.

2. Research Settings

River Manyera (also known as River Kontogora) runs through the Zuguruma Game Reserve section of Kainji Lake National Park, Niger State, Nigeria. It is a tributary of the River Niger, and it is on the border between Nasarawa-Kainji and Sabon-Pegi in Mashegu and Magama Local Government Areas of Niger State, respectively. The river lies between latitude 09° 71' N and longitude 04° 29' E. Several activities, including washing, drinking, bathing, fishing, cars washing, and crops and animal farming, take place near the river. Another notable activity that also occurs near the river is the mining of gold (gold ore processing), which is capable of emitting mercury into the environment [7, 8].

3. Methodology

Data for this study were collected using a questionnaire and in-depth interviews. More so, non-participant observation and a library search were employed for information on existing literature. The literature contains existing articles on heavy metals, specifically those carried out around the Manyera River, Niger State. The administration of the questionnaire for this study involved clustering the communities (Sabon-Pegi) into quarters. The quarters were identified by the names of their progenitors. From these quarters, 10 quarters were randomly sampled. Out of each of these quarters, 15 households were sampled; in each household sampled, a respondent was picked. In line with the patriarchal family system, the male heads of the household were given priority in the selection of respondents. The special privilege was given to households that have children under the age of 13 years. This is done to elicit information about the health situation of the age category that is regularly seen playing in Manyera River despite their vulnerability. The residents who were met while making use of the river at the time of data collection for this study were equally involved. Other regular users of the river who are willing to take part in the study were co-opted as well. This thus accounted for the remaining 50 respondents of the study population. The exercise was carried out within 5 weeks with the assistance of 6 field assistants who were students of a tertiary institution within the neighbourhood (Federal College of Wildlife Management, New Bussa, Niger State).

A total of 200 respondents sampled to get the needed data for the study were involved in the administration of the questionnaire. After data cleaning, only 194 copies of the questionnaire were involved in data analysis. To complement this, 20 participants were selected for the in-depth interview (IDI). These include 10 children who were selected from the river sides, 6 health officials, and 4 environmental health officers from the Health Centre located in the community. Data generated for the study through a questionnaire were processed using sample percentages to express the findings. Content and thematic analysis were used to extract information from the existing literature and data collected through in-depth interviews. For ethical issues, permission to interact with the respondents was sought from the District Head. The District Head politely assigned us two guides to accompany us in the field to interact with the respondents. The guides also helped in facilitating communication with the participants by translating from English to Hausa. The participants were assured of confidentiality and anonymity. The participants were also made aware of their right to terminate their participation in the data collection process at any time they wished.

4. Results and Discussion

4.1 Sociodemographic Characteristics

The total number of respondents was 194. The age distribution of the respondents shows 29.4% were between 18-30 years, 34.5% between 31-40 years, 23.7% between 41-50 years, and 12.4% above 50 years. By implication, it shows that the majority of the respondents are in the economically active group, which might explain their constant use of the river. In terms of education, results indicated 21.1% of the respondents did not have formal education, 28.9% had primary education, 32.0% secondary education, and only 18.0% had tertiary education. The relatively high proportion of respondents with basic or limited formal education suggests that awareness and understanding of environmental health risks associated with contaminated water sources may be constrained within the community. Meanwhile, it was established that the majority of the respondents 31.4% were farmers, 21.6% were involved in petty trading, 18.6% involved in artisanal mining, 15.5% were civil servants, and 12.9% engage in other informal activities like providing transportation services, fishing, and crafts. By implication, this explains that the community greatly depends on natural resources like the Manyera River.

4.2 Behavioral Attitude and Activities Observed in Manyera River

Out of the sampled respondents, 50% reported their patronage of the river daily; 28% visited it every weekend, and 22% visited the place only in the evening of every 3 days. Results revealed purposes of patronizing the river: bathing and washing clothes (27.2%), washing cars/lorry/motorcycles (18.1%), bathing (11.2%), washing agricultural products (8.4%), washing clothes (10.2%), processing of solid minerals (2.4%), and source of recreation for the children (22.5%).

4.3 Health Perception and Health Hazards Associated with the Usage of Manyera River

The majority of the respondents (17%) have never encountered any health challenges since they started going to the Manyera River; 11.3% maintained that it is not easy to encounter health challenges in a river that is not stagnant; 13.4% reported hearing from others who have been using this water for more than ten (10) years without any information of health challenges; and 10.8% expressed that the water is largely what everybody in the surrounding communities depends on for cooking, drinking, and other domestic uses. Another proportion (12.4%) submitted the river is God-given and remains dependable for every resident of the community. More so, 7.7% maintained that they cannot use any other source of water except the river; 8.8% submitted that the water is special and cannot harbor any health challenges because people come from far away to come and fetch it for spiritual healing. In terms of the diseases that could be found in the river: 7.2% posited that syphilis was a common disease being complained of by the users of this river; 6.2% reported that the usage of the river can cause skin disease, while 5.2% noted that rumored cases of river blindness were sometimes reported

4.4 Health Facilities Utilization and Behavioral Attitude of Users of Manyera River

Health facilities are utilized to cure ill-health situations encountered through the use of water in the Sabon-Pegi River. 28.8% reported usage of a clinic or hospital for their health challenges; 47.9% utilized home remedies or self-medication; and 23.2% combined hospital care with home remedies. Specific health conditions ever treated in the hospital according to further information, included malaria (21.1%), skin disease (16.4%), diarrhea (18.1%), cholera (12.9%), dysentery (17.6%), typhoid, and polio (13.9%). Furthermore, it was identified that the personnel in the community medical center often provides insight into the health situation among the residents of the community, particularly the children who are under the age of 13 years. In the words of one of them, "virtually every resident of this community makes use of water from the Manyera River. They have been advised several times on a safer approach to the usage of water from this river, since it is the only one that has been consistently providing their basic needs. Unfortunately, they have a nonchalant attitude toward this advice. While it is easier to convince the elderly about this, the children are often defying such advice. They have been battling with all sorts of health challenges that are river-water-related. It is only when the health challenges become debilitating that you see them as sober and ready to accept the inherent danger of the unwise usage of water from that river (IDI/Female/Nursing Superintendent, Sabon-Pegi Community, Niger State, Nigeria).

In another submission, the people here are usually displaying their ignorance of possible dangers in the usage of that river without proper treatment. They will tell whoever cares to listen that they have been using it since time immemorial. Meanwhile, the majority of them are afflicted with several water-borne diseases. When carefully observed, one will see that the danger in the Manyera River is grave when compared to other rivers within this environment, and this is as a result of the artisanal gold processing activities taking place at the bank of the river (IDI/Female/Environmental Health Officer, Nasarawa Community, Niger State, Nigeria). Further submission revealed that, most of the time, when

the people from this community present themselves for treatment at the health center, what they claimed were their health challenges were incorrect. They usually interpret their health condition based either on their understanding or the seeming similarity between what is presently afflicting them and that of others in their community (IDI/Female/Community Health Officer, Sabon-Pegi Community, Niger State, Nigeria).

Shedding light on the prevailing ill-health emanating from the use of water in the Manyera River, a participant revealed that we have treated several cases whose symptoms have been associated with cancer, cardiovascular diseases, and neurodegenerative diseases, which are equally common among the residents of this community. All the patients living with the aforementioned ill health have used and are still making use of the Manyera River for their daily activities. Their health conditions have degenerated and rendered them incapable due to the culture of keeping things to themselves until the situation gets out of hand. Premature death among children is very common (IDI/Female/Staff Nurse/Sabon-Pegi Community, Niger State, Nigeria).

It was stressed that several percentages (70) of the residents of the community were noted to have limited knowledge of the havoc wreaked by the Manyera River. Many have been infected with infections that have resulted in infertility and sterility (60%). This has created lots of marital instability among couples who are unable to give birth and those who cannot give birth to as many children as their culture demands. The situation is pathetic on the part of the children because they cannot do without going to the river for their recreational activities, especially swimming (IDI, Public Health Surveillance Officer, Nasarawa Community, Niger State, Nigeria). In another instance, a participant revealed that liver failure, kidney damage, gastric and skin cancer, mental disorders, and harmful effects on the reproductive system are very common among the children and older residents of the community. All these have a lot to do with the quality of water in the Manyera River and the poor attitude towards the treatment of the same before usage (IDI/Male/Environmental Health Officer, Nasarawa Community, Niger State, Nigeria).

Another expressed: "Several of the residents have a poor understanding of most of these diseases in terms of causality, perceived severity, and treatment. Mortality rates occasioned by waterborne pathogens have risen in the community. Cases of diarrhea, cholera, dysentery, typhoid, and polio are prevalent, though these are always attributed to non-medical causes. Other prevailing cases included birth defects, mental retardation, autism, psychosis, allergies, paralysis, weight loss, dyslexia, hyperactivity, muscular weakness, kidney damage, and brain damage" (IDI/Female/Nursing Superintendent, Sabon-Pegi Community, Niger State, Nigeria).

4.5 Observation of Activities on Manyera River and the Making of Heavy Metals

The position of earlier researchers on activities within the Manyera River, Niger State, Nigeria, was confirmed [7, 9, 10]. It was observed that the river is mainly used as a source of livelihood by the people around it since it serves as a source of irrigation for farming, among others. At the same time, there are sections within the riverbank where people wash their clothes. Yet the processing of gold (Au) mined around the neighboring communities by the artisanal miners is carried out within the banks of this river, thereby causing incessant pollution. The colour of the water in the Manyera River has an objectionable taste and odor, despite the World Health Organization standards, stating acceptable water that is fit for domestic use should be colorless, tasteless, and odorless. It can be concluded that the water in the Manyera River is not fit for use as drinking water except if treatment strategies are implemented.

This processing of gold (Au) involves activities like grinding, washing, drying, amalgamation with mercury (Hg), and melting of the amalgam to extract the Au. The grinding, washing, and extraction processes are done with bare hands and are devoid of any protective gear like eye goggles, nose guards, hand gloves, boots, overcoats, etc. Of all these activities, gold processing operations (milling, grinding, and concentrating ores) and disposal of tailings, along with mine and mill wastewater, are, in the words of [11], sources of environmental pollutants. Other environmental problems of gold mining include land degradation, deforestation, loss of aquatic animals, soil pollution, water pollution, and air pollution. Apart from the environmental concerns of gold mining, the health problems of gold mining are numerous due to the use of gravity concentration methods such as panning and sluicing during processing operations [12]. A study [10] affirmed the high concentration of mercury contamination in the artisanal gold mining area of the Manyera River. Mercury used for the amalgamation of gold after washing the mined soil in the river has led to the release of mercury into the stream. All studies conducted on this river, therefore, affirmed the presence of heavy metals therein.

The amalgamation process is based on the low surface tension between 'Au' and 'Hg,' which allows Au particles to be wet and enclosed by the liquid metal, forming an amalgam. Here, the ground Au ore tailing is subjected to washing and panning. The heavier 'Au' Loaded silt is recovered from the base of the pan and is combined with mercury to form a hardened amalgam. which picks up most of the gold from the silt. Heating the amalgam with blow torches or over an open flame evaporates Hg, leaving 'Au' pieces. Gaseous 'Hg' is inhaled by the processors and others in the vicinity, while un-inhaled 'Hg' settles into the surrounding environment or is transported and deposited far away. Elemental 'Hg' gives rise to a vapor that is only slightly soluble in water but is problematic because of its easy transport in the atmosphere [13].

Despite this, an appreciable number (60%) of children are always seen inside the river daily. The children have made it a routine to report to the river daily, and there is no hour of the day that one gets to the river without meeting a sizeable number of children engaging in swimming activities as part of their form of recreation. They are seen using their two hands to scoop the water from the river and drink it.

4.6 Public Health Implications of Activities at Manyera River

Mining and milling operations, together with grinding, concentrating ores, and disposal of tailings, are obvious sources of contamination in the surface environment, along with mine and mill wastewater [14, 12, 8]. Elevated levels of heavy metals can be found in and around mines due to the discharge and dispersion of mine waste into nearby agricultural soils, food crops, and stream systems [15]. This may eventually pose a potential health risk to residents in the vicinity of mining areas [9, 16].

Furthermore, it is alarming that people continue to make use of the water in this river daily despite the reported presence of mercury therein. The most frightening aspect of this is the fact that exposure to mercury causes diseases such as cancer, neurological disorders, autism, and, in some cases, death. Mercury is absorbed into the body through deposition in a variety of body organs, including the kidneys and brain [17, 18]. Though the body can naturally rid itself of mercury slowly through the urine and stool, meanwhile, an excessive amount accumulated over time can result in permanent damage to the kidneys, nervous system, and brain. The implication of this on pregnant women is also dangerous because elevated levels of mercury can pass on to the unborn babies, thereby affecting their development, especially the baby's brain, kidneys, and nerves. Mercury can also be passed from mother to baby through breast milk during nursing.

The children drinking the water from this river either deliberately or accidentally during swimming will be fatally impacted as well [26].

The World Health Organization (WHO) suggests that the maximum permissible concentration of mercury in drinking water should be 0.006 mg/L ($\mu\text{g/L}$). On the other hand, a study [10] found that the concentration of mercury in water samples collected from the Manyera River was 0.021 mg/L, which is far higher than the WHO guideline. The high concentration of mercury in the water indicates that drinking water without proper treatment could pose some potential health risks. It is worth noting that high levels of mercury pose greater health hazards due to the health problems that could arise, such as neurological disorders and fetal deformities, which are often associated with mercury poisoning. In general, it is evident that studies on the effects of heavy metals have significant health consequences. Acute effects of heavy metals include symptoms like fatigue, loss of appetite, insomnia, hallucination, vertigo, renal problems, and hypertension, while long-term effects include serious consequences like birth defects, impaired cognitive ability, renal and brain damage, paralysis, and death [9].

4.7 Social and Medical Consequences of Heavy Metals on the Host Communities

Heavy metals contamination due to mining and mineral processing (washing) has become one of the most silent but significant environmental side effects [20, 19]. Studies in the literature have reported on acidification and acid mine drainage associated with the mining of coal, gold, and other minerals containing pyrite and galena (FeS_2 and PbS) [12, 21]. Barite is one mineral or ore that has not been examined to pose such a threat, and although non-carcinogenic, may be associated with lead sulfide (PbS) and encrusted with pyrite or iron pyrite microcrystals [22, 23, 24]. Sulfuric acid mine runoff is unavoidable when barite tailings containing sulfide minerals are exposed to water and oxygen [24]. The consequence is the acidification of water, which can increase the release of other heavy metals such as iron, zinc, copper, lead, cadmium, arsenic, and barium.

The results of this study call for concern because they show how exposure to high concentrations of metallic, inorganic, and organic mercury from drinking contaminated water from this river can harm developing fetuses, kidneys, and brains. This, therefore, concerns the children who are fond of going to the river for swimming without knowing the immediate and long-term implications of what they are doing. Meanwhile, mercury contaminants were reported to be prevalent in the river [9, 10, 16]. A study [25] reported that mercury exposure also alters brain functioning and affects the neurological system, which can result in tremors, shyness, irritability, memory issues, and abnormalities in hearing or vision. While short-term exposure to organic mercury poisoning can result in depression, tremors, headaches, exhaustion, memory issues, and hair loss, short-term exposure to metallic mercury vapors at greater levels can cause vomiting, nausea, skin rashes, diarrhea, lung damage, elevated blood pressure, and other symptoms.

Heavy metals exposure can cause symptoms like anorexia, fatigue, and hypertension, while chronic exposure can lead to birth defects, mental retardation, autism, and even fatalities. High exposure to mercury vapor can cause severe airway irritation, pneumonitis, pulmonary oedema, lung damage, brain, nerves, kidneys, and even death. Workers exposed for 4-8 hours may experience chest pains, dyspnea, coughing, and pulmonary function impairment. Unsafe food concentrations of heavy metals can disrupt human body processes, leading to gastrointestinal disorders, stomatitis, tremors, diarrhea, hemoglobinuria, paralysis, vomiting, convulsions, and depression.

5. Conclusion

This study examined the environmental and public health implications of recreational water use in the Manyera River, Niger State, Nigeria, with particular emphasis on children's exposure to potential heavy metal contamination associated with artisanal mining activities. It has shown a wide array of challenges being encountered in the study area and thus becomes clear from the outcome that various human activities in developed and developing countries, particularly in sub-Saharan Africa (SSA), have given rise to environmental safety concerns. Increased artisanal mining activities and a series of environmentally non-sustainable practices are steadily creating unpleasant situations for people in developing societies. Despite this reality, the affected populace seems ignorant or not concerned about the precarious situations they are living in. Little attention is paid to the human and environmental impacts of the processes, particularly on the processors, the community members, and the children who constantly make use of the river as the only avenue for recreation through swimming. The implication of this is that these children are more or less infected with heavy metals, most especially mercury, which earlier studies have affirmed as having a concentration of between 0.014 and 0.025 mg/L, which is higher compared to the 0.001 mg/L limit recommended by the World Health Organization (WHO).

The children are likely to feel the brunt of this encounter more than the adults, given their immature organ systems and greater vulnerability. In the words of [26], these children are a high-risk category for heavy metal toxicity. Additionally, [27] submitted that these children have been exposed to heavy metals through the consumption of food prepared with water from the Manyera River. They equally drink the water during recreation and when they are at home, since this river serves as the mainstay of the community. The air within the community is polluted through the activities of artisanal gold processors, which absorb it via the skin. Their exposure to high levels of heavy metals portends great danger for their respiratory, cognitive, behavioral, and neurocognitive impairments, and cardiovascular and cancer issues in the near future [26]. With all these being glaringly showcased as dangers living with us, it is obvious that the prospects of future leaders are being toyed with.

In order to reduce the environmental and public health effects of heavy metals pollution, governments and health agencies need to give additional attention to the environment and anthropogenic activities. There is a need for regulatory authorities in SSA to be stricter in enhancing and enforcing existing rules in order to protect humans from heavy metals exposure resulting from the environment. Furthermore, since heavy metals occur as heterogeneous mixtures in the environment and are ubiquitous, there is a need for researchers to start looking for an alternative medicine since heavy metals have been shown to ward off treatment with modern medicine due to their toxicity.

6. Limitations of the study

It is important to point out that this study had some limitations. First, the study was based on the observed and reported health conditions affecting the community. In addition, the study relied on existing studies that documented the levels of heavy metals in the Manyera River. Lastly, the study was limited to a specific geographical area, specifically those communities near the Manyera River. It is therefore possible that the findings might not be generalized to other communities facing similar environmental conditions.

7. Recommendation

Therefore, in view of the findings, several policy and community-based interventions are recommended.

- ❖ Various government agencies that are responsible for environmental and public health issues should undertake regular environmental monitoring and laboratory testing of the quality of water in the Manyera River.

- ❖ Public health education campaigns should be advocated in these affected communities to create public awareness about the possible dangers associated with the use of untreated water in the river.
- ❖ Government and stakeholders should strive to develop and implement alternative sources of clean and safe water, to help in reducing the dependence of the community on the river.
- ❖ Environmental regulatory agencies should strengthen monitoring and regulation of artisanal mining activities in the river ecosystem.

Author Contributions:

Both authors contributed to the design of the study and draft of the manuscript. The first author worked on the methodology and collected the data while the second author performed the data analysis. Both authors contributed significantly to the revision or review of the manuscript and provided scientific advice. All authors have read and given their final approval for publication.

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