

AKSU Journal of Social Sciences (AKSUJOSS)
ISSN: 2504 – 933X
Vol.6,No.2 (September) 2025,pp.27-36
DOI: https://doi.org/10.61090/aksujoss.6.2.27-36
URL: htpp://www.aksujournal.com/vol.6.2

Received: **July 11, 2025**
Accepted: August 28, 2025
Published online: **September 13, 2025**

Implications of Water, Sanitation and hygiene for maternal and Child health: A community intervention study in Akwa Ibom State, Nigeria

Dorothy N. Ononokpono
Department of Sociology and Anthropology
University of Uyo, Uyo, Nigeria.
Ononokponodorothy@uniuyo.edu.ng

Aniefiok S. Ukommi
Department of Sociology and Anthropology
University of Uyo, Uyo, Nigeria.
annieukommi@gmail.com

Nsidibe A. Usoro
Department of Sociology and Anthropology
University of Uyo, Uyo, Nigeria.
ussh0074@gmail.com

Abstract

Poor access to water, sanitation, and hygiene (WASH) may adversely impact the health of mothers and their newborn babies at the time of pregnancy, delivery, and during the postpartum period. Despite the emphasis on the reduction of maternal mortality and improvement of women's health by 2030, the link between WASH and maternal health has not been adequately explored. Understanding the impact of WASH on maternal health could support efforts to leverage greater progress in reducing maternal mortality and improving maternal and newborn health. This study explored how WASH impacts women during pregnancy, childbirth birth and the postnatal period, as well as the perceived burden of diseases associated with poor WASH in Osuk Ntan community, Akwa Ibom State. Data were collected from a sample of 30 women of reproductive age (15-49) using in-depth interviews (IDI) and Focus group discussions (FGD); and thematic analysis was utilised for data analysis. The findings of the study indicated poor access to WASH infrastructure in the study community. The perceived burden of diseases associated with poor WASH reported by most of the women were dysentery, Diarrhoea, cholera, tract infections, itching skin, eczema, Typhoid, and malaria. There were also reports of miscarriages and injuries resulting from falls due to the bad condition of the road to the stream, which is the only source of water in the community. The outcome of the study was the implementation of an intervention program (borehole water scheme) to enhance access to WASH infrastructure, reduce the burden of the reported diseases, and improve maternal health in the study community. Furthermore, the study provided evidence-based data for future innovative WASH and maternal health interventions that can be replicated in other rural communities.

Keywords: Water, Sanitation and Hygiene, maternal and child health, Disease burden

Introduction

The increasing attention given to maternal health globally has been concentrated on the reduction of maternal mortality. The SDG target on maternal mortality forms an integral part of The Global Strategy for Women's Health, 2016–2030. Thus, accelerated progress is needed to achieve the SDG Target 3.1, and it will require a global annual rate of reduction of at least 7.3% (World Health Organisation (WHO), 2016). However, acceleration in reducingmaternal mortality may not be possible without clinical and non-clinical interventions-including WASH interventions.. Evidence showed that WASH impacts on maternal and newborn health at the time of pregnancy, delivery, and the immediate postpartum period through multiple direct and indirect mechanisms. Clinical studies have shown that the major complications that account for nearly 75% of all maternal deaths are: severe bleeding after childbirth (27%), infections

usually after childbirth (11%), and high blood pressure during pregnancy (pre-eclampsia and eclampsia) (14%) complications from delivery, Puerperal sepsis**,** and unsafe abortion (8%) (WHO, 2016). While the rest are associated with diseases such as malaria and AIDS during pregnancy.

The importance of WASH in maternal mortality reduction and improvement of reproductive health cannot be overemphasised. Without access to safe drinking water and basic sanitation, such as safe toilet facilities, women face dangerous health risks in pregnancy, during childbirth, and in the postpartum period, which could consequently lead to maternal deaths. The links between maternal health and water, sanitation, and hygiene (WASH) are multiple and occur not only during the continuum of care from pregnancy, to delivery, and the postpartum period, but also throughout the life of the mother and her child (Campbell et al, 2015). The quantity and the quality of water used can also have an impact on the pregnant woman. Water quality refers to both its microbiological and chemical (salinity, arsenic, fluoride) quality. Hepatitis E (HEV), for instance, is an illness that has a tremendous impact on pregnant women and is usually transmitted through faecal contamination of drinking water (Songa et al, 2015). Borehole contamination through septic tanks and latrines is also a pathway of transmission, as found by a study in Uyo, which documented 38% and 45% non Standard Organization of Nigeria (SON) and ARGOSS compliant, respectively (Ononokpono, 2015).

An estimated 70% of maternal deaths in sub-Saharan Africa could be prevented annually if everyone practised appropriate hygiene and had access to safe, reliable drinking water and sanitation (WHO, UNICEF, UNFPA, World Bank, 2023). Lack of access to water impacts maternal health through the physical burden associated with collecting water. Women and girls are saddled with the responsibility of water collection within households. Hence, Pregnant women who have to walk long distances and carry heavy jerry cans of water are at an increased risk of complications throughout pregnancy. Studies from Sub-Saharan Africa indicated that carrying water accounted for an average of 10% of the carrier's daily calorie intake (Cairncross & Valdmanis, 2006; Wenhold & Faber, 2009). Access to sustainable water and sanitation was associated with a lower maternal mortality ratio (Songa et al, 2015). Carrying water is one of the heaviest tasks and is known to affect weight gain during pregnancy and infant birth weight. In addition, arsenic is naturally present at high levels in the groundwater of several countries. Estimates showed that 136 to 178 million people worldwide drink water contaminated with arsenic above the WHO/FAO guideline of 10 parts per billion for drinking water (WHO, 2020). Contaminated water used for drinking, food preparation, and irrigation of food crops poses the greatest threat to public health from arsenic, known to increase the risk of cancer, cardiovascular disease, and anaemia, which in turn puts pregnant women at higher risk of severe bleeding (WHO 2019)

Some studies have demonstrated that women in low-resource communities practice poor WASH and menstrual hygiene management (MHM) (Bhakta et al. 2024; Daniel et al 2023). In addition, the authors further noted that some women experience sanitation insecurity despite having a safe and functional toilet. Furthermore, there is also suggestive evidence that WASH may have an impact on reproductive, maternal, and newborn health through multiple direct and indirect mechanisms throughout the life course (Mills & Cumming 2016). The impact of WASH on maternal health is enormous. Investment in water, sanitation, and hygiene has been greatly overlooked, yet it has the potential to improve maternal and newborn health. Notably, there is little evidence from non-clinical and qualitative studies on the impact of WASH on maternal and child health. Furthermore, there is a paucity of research on the impact of WASH on maternal health outcomes of rural women, and little is known about the burden of disease associated with poor WASH in rural communities. Studies that link WASH exposures to maternal health outcomes and also seek to explore maternal health disease burden that is

specifically associated with poor WASH are sparse. Existing research has largely examined maternal health and morbidity in isolation (Ononokpono & Odimegwu, 2016; WHO, 2014). However, understanding maternal health in relation to WASH, particularly among disadvantaged rural women, is important and would be useful to support the development of more nuanced, targeted guidelines on the link between WASH and maternal health.

Against this backdrop, the present study examined access to WASH infrastructure and its implications for maternal health, and perceived disease burden associated with poor WASH in Osuk Ntan community in Ibiono Ibom Local Government Area, Akwa Ibom State, Nigeria.

Literature review

Evidence of a link between water and sanitation and maternal and newborn health has been established; thus, improvements in water and sanitation are one of the ways through which the health of mothers and babies could be improved, and their lives saved (Benova et al, 2014). A study showed that at least 20% of maternal deaths are related to a lack of WASH, particularly sanitation. Furthermore, studies have indicated that more than 2 out of 5 maternal deaths occur within 24 hours of birth from causes related to haemorrhage and puerperal sepsis. Sepsis (bacterial infection in the bloodstream or body tissues) is mainly caused by unhygienic practices and poor infection control during labour and childbirth (Songa et al, 2015; Brooker, Bethony & Hotez, 2004). Similarly, clean hands are important to promote safe and healthy deliveries. Clean perineum and bathing – reduces the risk of puerperal sepsis. Pregnant women are more vulnerable to WASH-related diseases and infections associated with poor hygiene and water contamination. Howard et al (2010) found that a lack of water access leads to the inability of households to maintain hygiene, and water that is stored in-house increases the risk of water contamination, which may indirectly affect maternal health. This suggests that adequate sanitation is vital to interrupting the transmission of diarrhoeal and helminth diseases, also known as maternal anaemia. Galadanci et al. (2011) in a facility-based study, found a relationship between a combined measure of water and sanitation environment and a high risk of in-hospital mortality.

Access to water and sanitation is also essential for women living with the consequences of diseases, such as fistula, and for the healing of perineum ruptures and episiotomies. Furthermore, safe water is important for frequent cleansing of the genital area and in the management of obstetric fistula and prevention of infections. Poor WASH practices raise concerns across many dimensions and can lead to the adoption of harmful coping strategies. According to Khan et al (2011), an interplay of sociocultural, infrastructural, and household and community level factors acts as a mediating factor to limit the usage of WASH facilities by women in disadvantaged rural areas.

Theoretical Framework

This study was anchored on the social ecological model (SEM) developed by Urie Bronfenbrenner (1977). The theory emphasised that health behaviours and outcomes are affected by interactions between individuals and their environments at multiple levels, including individual, interpersonal, and community levels. Thus, SEM provides an appropriate framework for analysing WASH and maternal health issues; and also helps explain how poor water, sanitation, and hygiene conditions at the community level can adversely affect maternal health and child health, and enhance disease burdens.

Methodology

The study utilised a qualitative approach to collect data from a sample of women of reproductive age (15-49) years in Osuk Ntan - a rural community located in Ibiono Ibom Local Government Area, of Akwa Ibom State. Data were collected in two phases between June 2024 and April 2025. The study utilised purposive and convenience sampling techniques to select a

sample of 30 participants available during the study period. The sample was also determined by data redundancy or saturation. This is a point where the researchers could no longer elicit new insights from the participants' responses. In-depth interviews (IDI) and focus group discussions (FGD) were conducted, and the questions focused on women's access to portable water, implications of poor WASH, and the perceived maternal disease burden associated with poor WASH. One FGD was conducted to elicit details about concerns about the implications of poor WASH reported in the interviews. This helped to confirm if concerns reported in interviews were widely held by the participants. The participants were allowed to express freely and exhaustively on each of the questions regarding WASH and maternal health. The FGD was held in a private convenient venue and lasted for 60 minutes. Both IDI and FGD were conducted in the native language (Ibibio) by trained research assistants who are fluent in the native language. The interviews and FGD were recorded and translated into English and then transcribed for analysis.

Data Analysis

To analyse the transcribed data, first, analytic codes from the concerns were generated and applied to both the interview and FGD transcripts. Then, thematic analysis was used to examine themes and present participants' narratives based on access to water, impact of poor WASH on maternal health, and perceived associated maternal health diseases, as well as interventions to improve WASH in the communities. The Socio-demographic characteristics of the participants were analysed descriptively.

Results and Discussion

The socio-demographic characteristics of the participants indicated that the majority of the participants were aged 35 years and above, constituting 60.0% of the sample. Most of the participants were married or cohabiting (83.3%), and a large proportion of them had attained secondary or tertiary education. Results also showed that most of the participants were multiparous with four or more children, and the majority were farmers (76.7%).

Table 1. Percentage distribution of study participants by background characteristics N=30

Characteristics	N	%
Age		
15–24	2	6.7
25–34	10	33.3
35+	18	60.0
Marital Status		
Single	2	6.7
Married/cohabiting	25	83.3
Widowed	3	10.0
Educational level		
None/primary	5	16.7
Secondary/tertiary	25	83.3
Number of children		
0	3	10.0
1	2	6.7
2-3	3	10.0
4+	22	73.3
Occupation		

Farmer	23	76.7
Petty trader	5	16.7
Patent medical dealer	1	4.3
Student	1	4.3

Field work 2025

Water Quality and Access

All the respondents interviewed indicated that the major source of water in the community is the stream. The respondents consistently described the stream water as extremely polluted, visibly dirty with orange or brownish deposits, and unsafe for drinking. The respondents also described the problem of distance in fetching water. The stream is located far from their homes, requiring more than 2 hours walking distance, and the roads are steep and dangerous. Children, who sometimes helped their mothers to fetch water, take up to 3 hours longer due to playing along the way. As described by one of the interview respondents, the stream is contaminated and dirty:

"The stream water is very dirty, but it is all we have. The distance to the stream is very far, and the road is very steep and dangerous. If I am the one fetching, I use 80 minutes to and from the stream. But for children, they could use up to 3 hours because they play on the road. After fetching the water, it colours orange in the container, the colour of our water is orange all through, and we have orange particles and dirt in it" (Respondent 11, 49 years IDI).

Another respondent confirmed that the stream water is coloured with visible orange colour deposits:

"We fetch water from the rain during the rainy season. During the dry season, we depend on our very dirty stream. If you use water from the stream to wash your clothes, the clothes turn brown and orange. The water has never been clean, as it has orange deposits in it. After bathing in the water, I usually have itches, and everyone in the family also complains same. After fetching the water, we let it settle, then pour it into our containers. We do not boil it or filter it" (Respondent 12, Age 25 years IDI).

One of the participants re-echoed the view about the state of the stream water in the community:

"It is very unsafe and unclean, for instance, Water is fetched from a stream called Aqua, and the water is not suitable for drinking or doing anything. It has very brownish particles in it, such that it is not even suitable for washing clothes. Water is also obtained from the rains and stored in containers in houses. The distance from the houses to the stream is very far, about two hours is spent per trip for water, and the road is very steep" (Participant 13, 35years IDI).

Implications of poor WASH for maternal and child health

During the in-depth interview and Focus group discussion, the participants expressed their views on the implications of poor WASH on women in the community during pregnancy, childbirth birth and the postnatal period. Their views were discussed under the following sub-themes: perceived disease burden, adverse maternal health outcomes, and impact on child health.

Perceived disease burden

Participants were consistent in reporting that poor water, sanitation, and hygiene (WASH) conditions were associated with some infectious diseases that affect women, especially during pregnancy, childbirth, and postnatal periods. The perceived diseases include: dysentery, typhoid, diarrhoea, malaria, skin and tract infections. The poor hygiene and sanitation practices of open defecation and washing children's clothes containing faeces in the stream reported by

FGD participant indicate water contamination, which exposes other women and community members to germs and also enhances the spread of waterborne diseases:

"We have experienced outbreaks of dysentery in this community several times. Most women have a tract infection. These are traceable to poor hygienic practices. When mothers go to the stream and wash clothes that contain their children's faeces, the water body becomes grossly contaminated. There are germs in the water that cause itching for women. People practice open defecation in the surroundings, and when rain comes, it pushes the faeces down the stream. And people are at risk of dysentery" (Participant 8, 34 years FGD).

The participant further emphasised that:

"Mothers do wash their babies' Napkins in the upper section of the stream, and as it gently flows down, people on the lower section fetch it. That is how germs are being transmitted through the stream. Everyone in this village is facing this challenge, but women who are pregnant or nursing a child are seriously affected. Pregnant or nursing mothers living in poor environments are exposed to infection. I have seen many women struggling with fever, malaria, dysentery, and typhoid. This may lead to miscarriage" (Participant 8, 34 years, FGD).

In the interview session, one of the participants narrated her experience of swelling legs and recurrent typhoid, diarrhoea, and other infections during pregnancy perceived to be associated with the consumption and use of unsafe water. There was also an expression of concern about the safety of the water for pregnant women and their unborn babies:

"When I was pregnant, my legs used to swell beyond normal. When I go to the hospital, they will say it is caused by the kind of water I am drinking. Some other women have experienced the same thing, too. I have fallen sick a lot of times, and each time I go to the hospital, they keep asking me, What kind of water do you drink, Is the water tested to be safe for drinking? I have had a series of typhoid and diarrhoea. We use the water to clean our private parts when we shower, and we just wait till it settles down. So for women who are pregnant, drinking the water is unsafe for their unborn babies" (Participant 22, 36 years IDI).

The issue of recurrent typhoid, perceived to be associated with poor WASH, was also admitted by other participants:

It causes typhoid and severe fever, and headache. Unfortunately, I hardly go to the hospital because of the cost. I just go to the pharmacy, but it only takes a few months, and I am back to the chemist with the same complaint or something new, and they usually ask me to change my water. The constant antibiotics make me feel dizzy and weak sometimes. I sometimes have blackout" (Participant 4, 48 years IDI).

"We have a lot of cases of measles, typhoid, and diarrhoea; the health workers tell us it is from our water and hygiene practices. This is enough to cause death in children. We have cases of children dying and also pregnant women having issues in the village. It is mostly caused by high fever and typhoid. You will see the baby convulsing and dying, and this results from malaria, which is caused by the water that we consume. At least that is what we are told if we go to the hospital" (Participant 11, 49 years, IDI).

The participants reported that the contaminated water used caused skin rashes, eczema, and itching for both children and adults. Lack of access to clean water for maintaining personal hygiene and washing reusable sanitary materials was perceived to increase the risk of genital infections, which are harmful during menstruation and pregnancy. One of the participants stated:

"The water also affects our health because it has reactive effects on our skin. Both children and adults struggle with skin rashes and eczema as a result of using contaminated water" (Participant 2, 42 years, FGD).

Stressing the harmful effect of the contaminated water used by women in the community, another participant reiterated:

"We experience rashes on our bodies when we bathe with the water from our stream. When someone comes in contact with contaminated water, it is possible to have a skin infection. When a woman does not have access to clean water to bathe, she can transmit germs to her reproductive organs. And this is very risky during pregnancy. Also, during menstruation, women who rely on pieces of cloth as sanitary pads rinse them in contaminated water and reuse them, thereby increasing the rate of infection" (Participant 1, 45 years FGD).

Adverse maternal health outcome

The narratives indicated that the physical burden of fetching water from distant, steep, and unsafe locations negatively affects pregnant and nursing women in the community. There were reports of falls leading to injuries, emergency hospitalisation, and miscarriages in the process of fetching water from the stream. This is an indication of severe risks posed by the environment and the responsibility of water-fetching.

Excerpt from the interview revealed critical adverse maternal health outcomes experienced by women in the community:

"Women go through a lot in this community because of a lack of a good source of water. After delivery, a woman needs to take care of herself and her baby very well. As a woman, you do a lot of cleaning and washing. So, in this community, it is not easy to maintain cleanliness as a mother.. Again, the burden of fetching water is on women, since children find it difficult to climb the hill. This responsibility affects pregnant women and nursing mothers. There was a time a woman fell to the ground and had a miscarriage while climbing a hill" (Participant 7, 46 years, FGD).

Another participant confirmed that:

"A lot of pregnant women do fall on their way back from the stream, most of them complain of weakness and dizziness as the cause of their fall" (Participant 12, 25 years, IDI).

A report of the case of emergency medical interventions following falls highlighted the critical maternal health impact of poor WASH infrastructure in the study community:

"As a patent medicine dealer, I have treated many injuries of wounds acquired by women on the way to fetch water from the stream. I have also treated women who have come to me as a result of complications acquired; some of the pregnancies do not withstand the fall, but the majority do. There is a recent case where the mother had to be rushed to the hospital in town for the baby to be operated on after she fell. She is alive and the baby is fine" (Participant 13, 35 years IDI).

Impact on Child Health

The reports indicated frequent illness and mortality in children, with many cases attributed to contaminated water and poor sanitation. The incidence of malaria, fever, and dysentery was also linked to poor water quality, with emphasis on the general health implications for the household:

"I boil the water for my baby, but times where the boiled water has finished and my baby is thirsty, I just give him the water like that. He has also had diarrhoea problems as a result" (Participant 12, 24 years IDI).

Respondents further revealed that children are also at serious risk of contracting water-borne diseases:

"Our role as caregivers makes us need water more than men. The poor quality of the water supply puts those we care for, especially children, at serious risk of developing fever or dysentery. Since the whole community has no health centre, it is difficult to access health care (Participant 5, 31 years, FGD).

Discussion of findings

The findings of this study highlighted the implications of poor WASH infrastructure on maternal and child health in the Osuk Ntan community in Akwa Ibom State. The findings specifically indicated poor water quality and access, sanitation, and hygiene in relation to maternal and child health. Perceived diseases associated with poor WASH were also documented. All interview respondents and FGD participants reported that the stream in the community was the primary water source, describing it as unsafe for drinking and household use for washing, because it was extremely polluted with visible orange or brownish deposits and particles. This finding corroborates a study by Adefisoye and Okoh (2016) in rural Nigerian communities. The water colour and particle deposits may likely indicate contamination, possibly from rock sediments characterising the topography of the community or pollution from human and animal waste. The long distances and difficult hilly terrain posed tremendous challenges in accessing the stream. Reportedly, it required more than two hours of walking to access the stream, and this experience exacerbated the burden of water fetching on women and children. This result supports the findings of a study in sub-Saharan Africa, which indicated that distance and accessibility significantly impact water collection efforts and health outcomes. The physical difficulty and danger in accessing water could be attributed to the rocky terrain in which the community is situated.

The findings further indicated that poor water, sanitation, and hygiene (WASH) were associated with perceived burden of diseases, corroborating the study in middle-income studies by Prüss-Ustün et al. (2019). All the participants consistently linked unsafe water and poor hygiene to outbreaks of water-borne diseases such as dysentery, typhoid, diarrhoea, and skin infections in the community. The use of contaminated water for bathing and washing reusable sanitary materials was also associated with skin rashes and reproductive tract infections, reinforcing the link between poor hygiene practices and increased infection risks. The implications of poor WASH for maternal and child health were also evident. This aligns with the World Health Organisation Report, which emphasised the role of WASH in maternal and child infectious diseases in low-resource settings (WHO 2020). The burden of diseases experienced by women and children in the study community may be due to water contamination. The poor hygiene and sanitation practices of open defecation and washing of contaminated clothes in the stream could further spread infections. The reports of recurrent infections during pregnancy, falls injuries, and the risk of miscarriages and emergency hospitalisations due to the physical burden of fetching water and hazardous terrain are supported by other studies, which noted that poor WASH conditions increase maternal complications and adverse birth outcomes (Smith et al. 2017; Onyango-Ouma et al. 2014). Similarly, the implications for child health were also profound, with reports of frequent illnesses and diarrheal diseases attributed to unsafe water and poor sanitation, corroborating the findings by Cairncross et al. (2010). These findings could be related to poor WASH infrastructure in the community and environmental factors that affect maternal and child health. Furthermore, the results highlight the gendered burden of water collection and its health implications for women.

Conclusion

The study demonstrated that poor water quality and access to safe water sources, sanitation, and hygiene have severe implications for maternal and child health in the study community, like in other rural Nigerian communities. Poor WASH contributes to recurrent perceived burden of diseases, skin and tract infections, adverse pregnancy outcomes, and increased child morbidity. The physical burden and responsibility of water fetching further worsen maternal health risks. To reduce exposure to contaminated water and physical strain during water collection, there is a need for the provision of a safe and accessible clean water source close to the community.

Acknowledgments

The authors would like to thank the Nigeria Tertiary Education Trust Fund (TETFUND) for funding this research; the women who participated in this study, for their time and trust during the data collection processes; and the community leaders for permission to conduct the survey. The authors are also grateful for the assistance provided by the research team.

Funding

This work was supported by the Nigeria Tertiary Education Trust Fund under Grant number-REF: TETF/DR&D/CE/UNI/UYO/IBR/2024/VOL 1.

Conflicts of Interest. No potential conflicts of interest are reported by the authors.

Ethical Approval. The University of Uyo Institutional Health Research Ethics Committee (UNIUYO-IHREC) approved the study.

REFERENCES

Adefisoye MA and Okoh AI. (2016). Assessment of the physicochemical and bacteriological quality of water from four commercial dams in the Eastern Cape Province, South Africa. International Journal of Environmental Research and Public Health,*13* (1), 139. https://doi.org/10.3390/ijerph13010139

Bartram J and Cairncross S (2010). Hygiene, Sanitation, and Water: Forgotten Foundations of Health. PLoS Med 7(11): e1000367. https://doi.org/10.1371/journal.pmed.1000367

Benova, L, Cumming, O and Campbell, O. M. R. (2014). Systematic review and meta-analysis: association between water and sanitation environment and maternal mortality. Tropical Medicine and International Health, *19*(4), 368–387. https://doi.org/10.1111/tmi.12275

Bhakta, A., Mansuri, A., Jaiswal, J. and Iyer, M (2024). The need of the hour: Providing water in shared toilet facilities for menstrual hygiene management in urban India. Journal of Water, Sanitation and Hygiene for Development, 14(2): 113 doi: 10.2166/washdev.2024.265

Bronfenbrenner, U. (1977). *Toward an experimental ecology of human development. American* Psychologist, 32(7), 513–531. https://doi.org/10.1037/0003-066X.32.7.513

Cairncross, S., Hunt, C., Boisson, S., Bostoen, K., Curtis, V., Fung, I. C., & Schmidt, W. P. (2010). Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology, 39*(Suppl 1), i193–i205. https://doi.org/10.1093/ije/dyq035

Cairncross, S, and Valdmanis V (2006). Water supply, sanitation, and hygiene promotion," in Disease control priorities in. Washington, DC: World Bank, vol. 2nd edition.

Campbell, O. M. R., Benova, L., Gon, G., Afsana, K., and Cumming, O. (2015). Getting the basic rights – The role of water, sanitation and hygiene in maternal and reproductive health: A conceptual framework. *Tropical Medicine & International Health, 20*(3), 252-267. https://doi.org/10.1111/tmi.12439.

Daniel, N., Kejela, G., Fantahun, F, Desalegn, M and Guteta, F (2023). Menstrual hygiene management practice and its associated factors among in-school adolescent girls in Western Ethiopia. Contraception and Reproductive Medicine. **8** (10) (https://doi.org/10.1186/s40834-022-00196-7

Wenhold, F and Faber, M (2009). Water in nutritional health of individuals and households: an overview," Water SA, 35(1).

Galadanci, H., Künzel, W., Shittu, O., Zinser, R., Gruhl, M., and Adams, S. (2011). Obstetric quality assurance to reduce maternal and fetal mortality in Kano and Kaduna State hospitals in Nigeria. International Journal of Gynecology & Obstetrics, 114(1), 23-28.

Howard, G. and Bartram, J.K (2010). Domestic Water Quantity, Service, Leveland Health. 2003, World Health Organisation

Khan AE, Ireson A, Kovats S, Mojumder SK, Khusru A, Rahman A, Vineis P. Drinking Water Salinity and Maternal Health in Coastal Bangladesh: Implications of Climate Change. Environmental Health Perspective.119(9):1328–32. doi: 10.1289/ehp.1002804.

Mills, JE and Cumming O (2016). The impact of water, sanitation and hygiene on key health and social outcomes: review of evidence. SHARE/UNICEF

Ononokpono, D.N and Odimegwu, C.O (2016). Maternal Health Care Behaviour in Nigeria: the role of female autonomy. International Journal of Social Sciences, 10 (2):180-194

Ononokpono A.E. (2015). Potential for borehole water contamination from on-site sewage: A case study of residential housing in Uyo, Nigeria. Unpublished MSc. Dissertation, University of Derby, United Kingdom.

Onyango-Ouma, W. Aagaard-Hansen, J., and Jensen, B. B. (2014). Hygiene and sanitation practices in rural Kenya: Linkages to health outcomes. In *Environmental health: Ecological perspectives* (pp. 53-70). Springer. https://doi.org/10.1007/978-0-387-92269-0_4

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V et al. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. *International Journal of Hygiene and Environmental Health, 222*(5), 765-777. https://doi.org/10.1016/j.ijheh.2019.05.004

Brooker, S., Bethony, J., and Hotez, P. J. (2004). Human Hookworm Infection in the 21st Century. *Advances in Parasitology*, *58*, 197. https://doi.org/10.1016/S0065-308X(04)58004-1

Songa, I., Macline, M. and Rakuom, C. (2015). Maternal child health through water, sanitation and hygiene. Sky Journal of Medicine and Medical Science, 3(7), 94–104.

World Health Organization. (2023). Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; . Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization. (2020). *WHO global water, sanitation and hygiene: Annual report 2019*. Geneva: World Health Organization.

World Health Organization (2019) Preventing disease through healthy environments exposure to arsenic: A major public health concern. Geneva: World Health Organization

World Health Organization. (2016). *World health statistics 2016: Monitoring health for the SDGs, sustainable development goals*. World Health Organization. https://apps.who.int/iris/handle/10665/206498

World Health Organization. (2014). *Maternal mortality and morbidity. Maternal mortality factsheet*. No.348.Geneva: World Health Organization