United Nations University
Institute for Water, Environment and Health

Unmasking the Unseen

The Gendered Impacts of Water Quality, Sanitation and Hygiene



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Unmasking the Unseen
The Gendered Impacts of Water Quality, Sanitation and Hygiene

Grace Oluwasanya

Ayodetimi Omoniyi

Duminda Perera

Manzoor Qadir

Kaveh Madani

United Nations University Institute for Water, Environment, and Health (UNU-INWEH)

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Front cover image: Residents scrambling for water in a hole due to inadequate WASH services. *Photo: Punch Newspaper/Olatunji Obasa*

Back cover image: Clean water crisis in Asa Community, Ogun State, Nigeria. *Photo: X.com/Ebube Chukwu*

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Women and girls as primary water collectors.
Photo: Flickr/Axel Fassio/CIFOR, CC BY-NC-ND 2.0

Glossary of Abbreviations

BH	Boreholes
DIA	Differential Impact Assessment
HDW	Hand-dug wells
LMIC	Low- and middle-income countries
MHM	Menstrual Hygiene Management
PHCs	Primary Healthcare Centres
RTIs	Reproductive Tract Infections
SDG	Sustainable Development Goal
STW	Sachet (Packaged) Water
UTI	Urinary Tract Infection
WASH	Water, Sanitation and Health
WRID	Water-related Infectious Disease
VOCs	Volatile Organic Compounds

Keywords	Description
Differential impact analysis	Differential impact analysis is one due to at least, gender differences across age groups. Such analysis is expected to unmask typically unseen gendered water-related health and its associated impacts within the water-gender intersections.
Gender – The construct/concept	The concept of gender, perceived as a social construct typically described in femininity and masculinity, transcended bilinear sexual identities to multi-sexual identities that include the transgender or LGBTQIA. Also, the construct is not a shorthand for women, and the interplay of gender and water does not connote the need to address only female vulnerability.
Gender neutrality	Denotes 'not relating or specific to people of one particular gender'. But effects due to water-related services, practices, and events are not gender neutral.
Water-related health impacts	Diseases associated with water are, essentially, defined as water-related infectious diseases – WRID. Such diseases vary from water-borne (Ingestion of pathogens in contaminated water, e.g., typhoid) to water-washed (Poor hygiene/lack of access to safe water, e.g., diarrheal diseases), water-based (Infection by agents that spend part of their life cycle in water, e.g., schistosomiasis), and water-related vectors (Spread by vectors that breed or bite near water, e.g., malaria).
Menstrual Hygiene Management - MHM	This reflects using a clean menstrual material that can be changed in privacy as often as necessary for the duration of a menstrual period to absorb or collect menstrual blood, using soap and water for washing the body as required and having access to safe and convenient facilities to dispose of used menstrual management materials.

Executive Summary



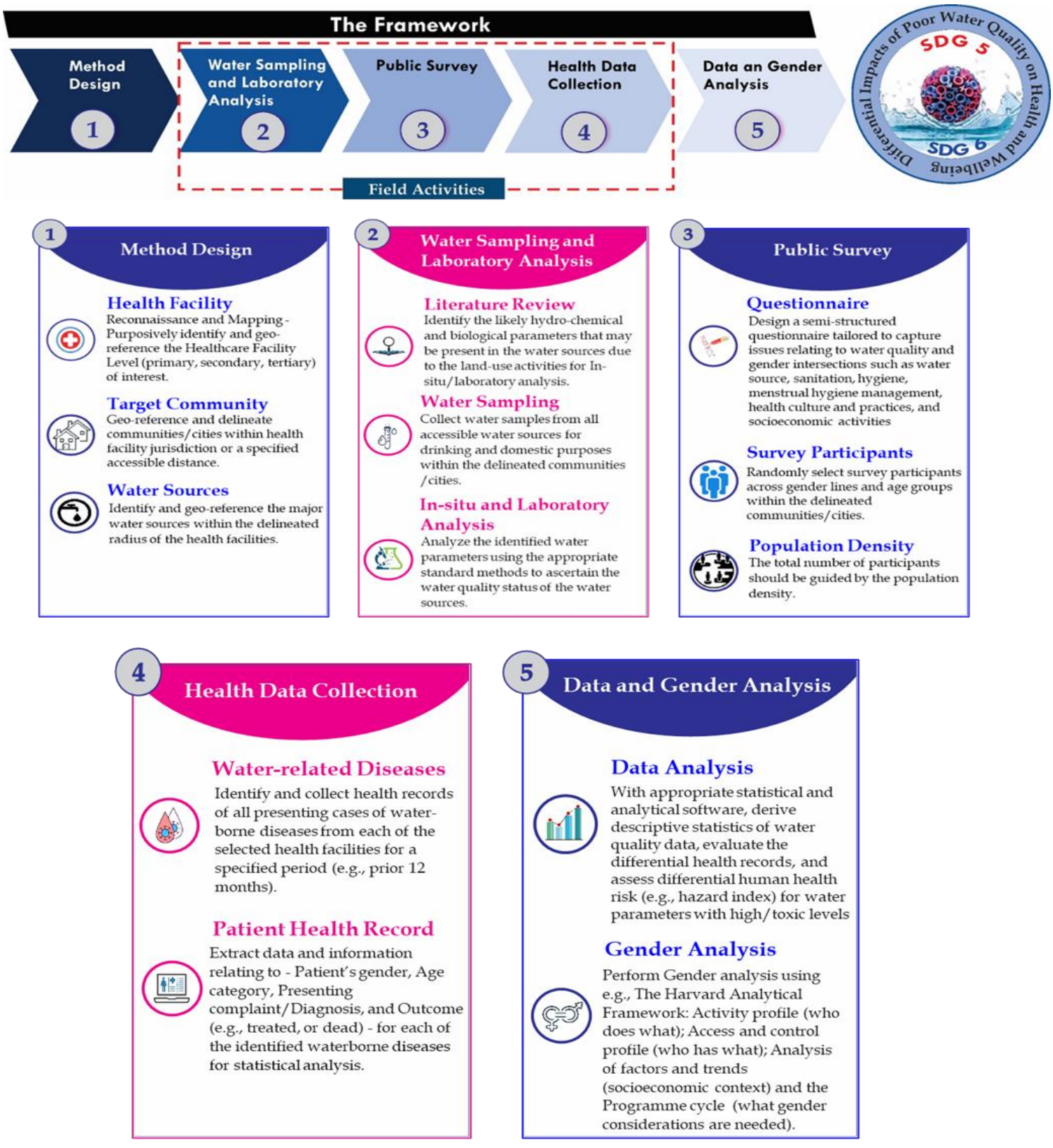
Front view of a woman looking intently at a blurry glass of drinking water. *Photo: Freepix*

There has been a historical acknowledgment of the association between unsafe water and public health in the water sector. Water serves as the primary pathway for conveying pathogens and chemicals to millions of people due to its distinct property as a universal solvent capable of dissolving nearly any substance it encounters. Millions of people suffer from diseases linked to water, leading to significant morbidity and mortality annually. Many studies have explored the relationship between unsafe water and public health, illustrating how poor water quality and inadequate water, sanitation, and hygiene (WASH) practices increase the risk of water-related infectious diseases (WRID). Others addressed the impacts of the increasingly prevalent climate change and anthropogenic activities on the quality of drinking water, underscoring domestic, agricultural, and industrial activities, insufficient waste management, and natural events as significant sources of water contamination. Some even investigated the influence of water-related (WASH and MHM – menstrual hygiene management) factors on health issues specific to women, men, boys, and girls, e.g., the prevalence of reproductive tract infections (RTIs) among reproductive-age women. Generally missing, however, are studies into holistic gendered impacts.

Differential Impact Assessment (DIA) is a pivotal tool in understanding the varied effects of water-related issues across different populations, groups, and geographical areas. Exploring how specific policies or phenomena affect diverse entities differently, including accentuating the relevance of gender and age groups, as shown in this report. Interestingly, ambiguous implications such as "*The impacts of climate change-induced water quality and natural events differ for men and women*..." are frequently cited, yet the extent or magnitude of these differences are barely quantified. Also, though the adverse effects of unsafe water on health are acknowledged, the distribution of reported cases among men, women, boys, and girls is often overlooked or hardly documented. Since the start of the global Sustainable Development Goals (SDG) initiative in 2015, the monitoring of WASH services predominantly concentrated on the general population, as evident in SDG 6.1, 6.2.1a, and 6.2.1b, measuring the proportion of the population utilizing safely managed drinking water, sanitation services, and handwashing facilities at home, respectively. However, as the world approaches the 2030 deadline for the SDGs, monitoring of differential access to WASH services or its impact analysis is limited. Indicating that the analysis of differential impacts is often disregarded as a crucial component in mitigating the consequences of water-related concerns such as deteriorating water quality on health and socioeconomic well-being. Also, notably absent is an established standardized protocol for collecting sex-disaggregated data to facilitate such analysis. These limitations further obscure the invisible gender-specific dimensions of health and associated impacts.

As part of its Strategy 2020-2024, The United Nations University Institute for Water, Environment and Health (UNU-INWEH) investigated the interplay between water quality, WASH, and gender. This analysis examines distinct variables of water quality and their varying impacts on gender, like reported water-related illnesses of males and females, and the consequences of water quality, sanitation, and hygiene on menstrual hygiene practices, particularly focusing on low- and middle-income countries (LMICs). The aim is to understand the diverse impacts and gender-specific risks associated with declining water quality and managing water, sanitation, and hygiene. The objectives align with the call by SDG 3 to address health priorities, including reproductive, maternal, and child health, SDG 5 to attain gender equality and empower women and girls, and SDG 6 to ensure universal access to safe water and sanitation. In addition, the initiative calls for expanding scientific monitoring of sex-disaggregated data in the water domain to uncover the often-ignored or strategically dismissed linkages between water and gender for effective and fit-for-purpose management of water resources based on their quality.

This report presents the key findings from the study, outlining a framework and guidance for examining gender-specific impacts stemming from poor water quality and WASH practices through a piloted case study in Abeokuta City, Nigeria, to serve as a preliminary guide for conducting comprehensive, site-specific assessments. The piloted assessment framework is a 5-step approach, guiding the evaluation of gendered impacts from method design to the field activities, which include water sampling and laboratory analysis, public survey, and health data collection, to the data and gender analysis, hoping it will equip professionals across water, climate, gender, health, and related disciplines and sectors with the tool to assess location-specific gendered impacts of unsafe water. The focus on low- and middle-income countries underscores the importance of DIA in such regions for better health and socioeconomic outcomes. This report also discusses the lack of a standardized protocol for monitoring sex-disaggregated data, shedding light on the unseen global-scale gendered impacts of unsafe water. It further provides information on addressing the observed gendered impacts of unsafe water on health and well-being in the study area and, by extension, in areas with similar characteristics.



The 5-step Differential Impact Assessment Framework

KEY FINDINGS:

- Without point-of-use water treatment, the water sources in the study area are not safe for potable purposes.
- There are clear differential impacts of WASH services and practices on human health.
- Poor menstrual hygiene among girls remains a dire health risk both in the near and future term.
- Access to WASH services in the study area is grossly inadequate and achieving SDG 6 by 2030 is highly unlikely.
- Enhancing women's economic status could significantly affect access to better healthcare services and transform household well-being.

Water hardness, which is strongly related to heightened levels of calcium (Correlation coefficient = 0.97), is observed in three (Hand-dug wells-HDW, boreholes-BH, and surface water-SW) of the four most common water sources in the study area. The elevated calcium content may have also influenced the low pH levels of those sources. Among the hydro-chemicals examined, calcium poses the most substantial health risk (non-carcinogenic) across all water sources, with men and boys being more susceptible than women and girls. Additionally, all the water sources tested have microbial contamination. Disease-causing pathogens, including enteric and opportunistic microbes, were detected in varying amounts greater than 0 CFU 100 mL-1 of water – this particularly raises concern about the safety of the water for human consumption. Therefore, the absence of point-of-use water treatment and apt water safety planning endangers the potability of water from these sources.

Water-related illnesses are the most prevalent of the diagnosed health cases at the primary healthcare centers (PHCs) in the study area, disproportionately affecting women. Malaria stands out as the most common ailment, accounting for 68.1% of cases, while pelvic inflammatory disease/urinary tract infection and skin/dermal infection, at the lower end, account for 1.9% and 1.8%, respectively. While women and girls predominantly rely on packaged sachet water (STW), men and boys more frequently utilize BH and HDW. Simultaneously, disparities in access to sanitation facilities reveal a worrying trend: women who utilize and share these facilities more frequently often lack access to adequate handwashing facilities compared to men and children. Children, particularly girls, bear an uneven burden of water collection compared to adults. The responsibilities associated with toilet cleaning primarily fall on women, to a lesser extent on girls, while men and boys contribute less. Despite having better access to handwashing facilities, men and boys demonstrate lower compliance with handwashing practices after toileting. These disparities suggest that girls face the most significant impacts from water collection activities like experiencing fatigue, related adverse health effects, and sacrificing time that could otherwise be utilized for productive activities such as schooling or studying. Conversely, while boys and men may face increased risks of diseases like diarrheal illnesses due to poor hygiene practices, women may be more vulnerable to health effects like throat irritation and nausea because of exposure to volatile organic compounds (VOCs) found in disinfectants used for toilet cleaning than others.

Predominantly, BH and HDW are used for menstrual hygiene management. Though most women and girls prefer disposable sanitary pads, women change them more frequently than girls. Also, women exhibit better menstrual hygiene practices than girls, maintaining genital and hand hygiene by washing with soap and water, both before and after changing the menstrual materials. To manage menstrual hygiene needs, women prefer the privacy of their bedrooms at home or rooms other than the toilet when outside their homes, but girls prefer the privacy of the toilet, whether at home or away.

STW, often considered safe as it is sold as treated, serves as the primary drinking water source in the absence of a public water supply. However, communal boreholes and HDW are mostly utilized for cooking and various domestic purposes like bathing, laundry, and sanitation, respectively. The majority, approximately 82% out of 456 participants, utilize less than the recommended 50-100 L/person/day, and more concerning, 86% (drinking) and 91% (domestic uses) of participants apply no form of water treatment. Also, nearly all participants (about 98%) use and share improved sanitation facilities like flush toilets and lavatories, but worrying is the unsafe closeness of these facilities to water sources - mostly less than 30 meters, which could pose contamination risks. About 74% also lack access to essential handwashing facilities - this exacerbates the difficulties, particularly in maintaining adequate hygiene practices, which are crucial for public health.

Disparities in access to water, sanitation, and hygiene facilities in Abeokuta City, Nigeria

Water sourcing:

- Children, especially girls, bear a greater responsibility for water collection relative to adults.

Sanitation and Hygiene:

- Women predominantly utilize and share sanitation facilities but lack access to handwashing facilities compared to men and children.
- The responsibility of toilet cleaning is primarily on women and, to a lesser extent, girls, than men and boys.
- Despite having greater access to handwashing facilities, men and boys are less likely to wash their hands after using the toilet.

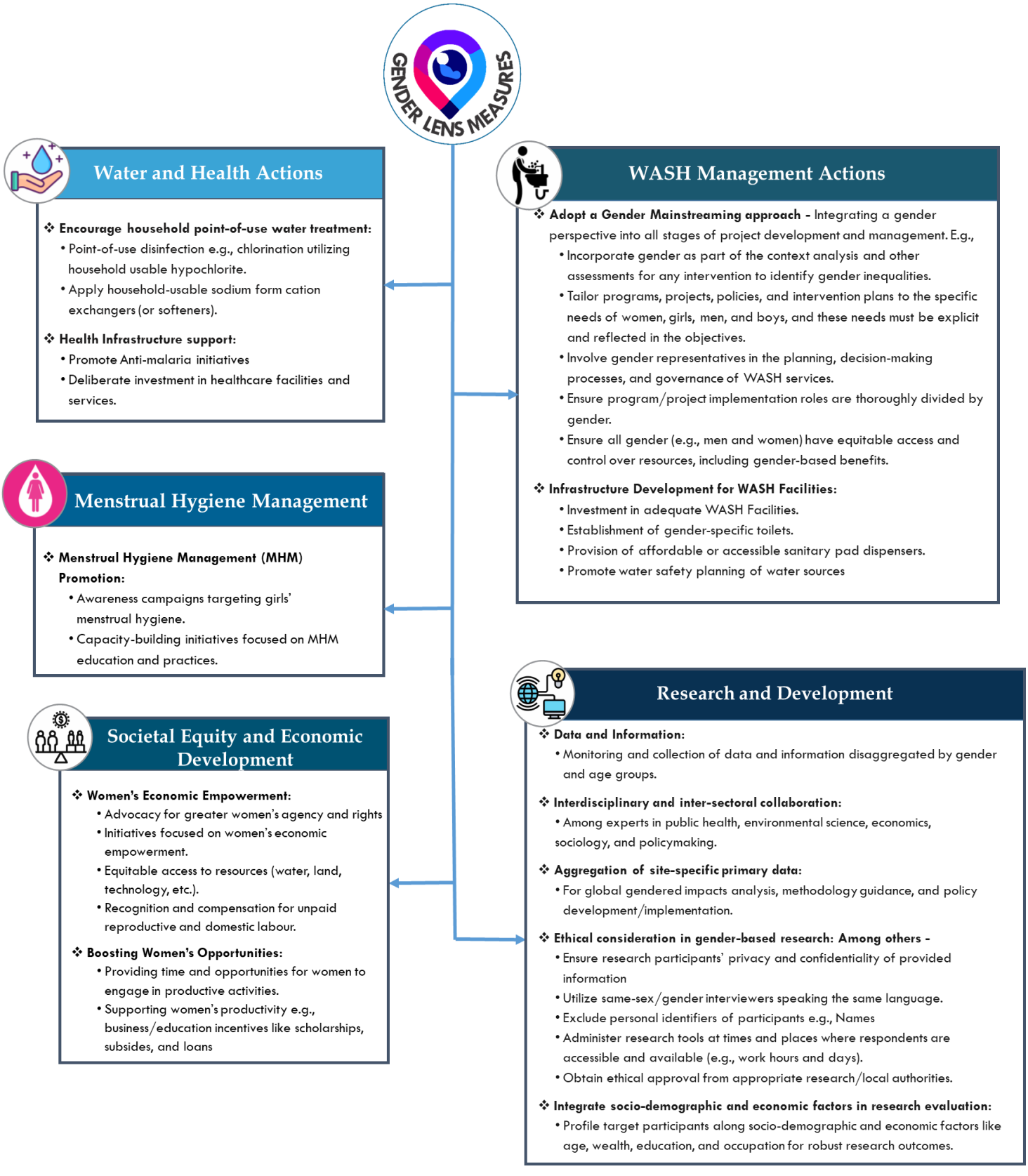
Health Burdens:

- Water-related illnesses are more frequently reported by women, these diseases constitute the highest number of diagnosed health cases, with malaria being the most prevalent.
- Girls are disproportionately affected by the impacts associated with water collection, leading to fatigue, reduced time for education and social activities, and related health issues.
- Sharing sanitation facilities with men and boys poses risks for women, including pregnancy complications and genital/urinary infections, aside from increased vulnerability to abuse and sexual assault.

Despite the lower wealth status of women, the agency (who makes decisions on healthcare matters) of household healthcare rests more on women than men. Also, even though the majority (68%) practice self-help health care, it is intriguing that more women target a higher level of healthcare services, preferring private secondary healthcare centers and pharmacies than men. Men utilize primary healthcare centers or resort to self-medication. These findings agree with the socially ascribed reproductive roles often attributed to women, emphasizing their responsibility for childcare and healthcare within the household.

Overall, the study underscores the gendered impacts of unsafe water, inadequate WASH services, and practices on human health and total well-being, emphasizing that gendered statistics through sex-disaggregated data is crucial to uncover the often-overlooked differential impacts, which are not gender-neutral or evenly distributed across age groups.

Addressing gendered impacts on health and well-being demands implementing multifaceted solutions that prioritize equitable access to WASH services, promote better MHM for girls, empower women economically, and ensure the active participation of all genders in decision-making processes. Such initiatives are essential for improving health outcomes and transforming household well-being, particularly in the study area. The report calls for targeted actions, including urgent planning and implementation of robust water safety protocols for non-utility self-supply systems and mainstreaming gender concerns and needs as a "6th sense" accelerator for SDG 6. The methodology developed and piloted here is scalable and serves as an introductory guide that can be further refined to explore and track site-specific differential health and socioeconomic effects of inadequate water quality, especially in locales similar to the study area. This report targets policymakers and donor organizations advocating for sustainable water resource development, public health, and human rights, as well as those promoting gender equality to enhance global, regional, national, and community-level water management.



Targeted Actions to Address Gendered Impacts of Water Quality, Sanitation and Hygiene

Variables		Women	Men	Girls	Boys
WASH Characteristics	Sachet water for drinking				
	Shared improved sanitation facility				
	Open defecation				
	Access to a handwashing facility with soap & water				
WASH & Health practices	Water collection				
	Toilet cleaning				
	Handwashing with soap				
	Healthcare decision				
	Use of Tertiary Health facility				
	Use of Secondary HC (public)				
	Use of Secondary (Private)				
	Primary Healthcare Center				
	Pharmacy				
	Self-Medication				
	Homecare				
Socio-economic characteristics	Low-income				
	Lower-middle income				
	Middle income				
	High income				
	Self-pay healthcare				
	Government/Private Insurance				
Menstrual Hygiene Management (MHM)	Frequency of changing menstrual material				
	Handwashing before changing				
	Handwashing after changing				
	Genital washing with soap				
	Privacy of changing in the toilet				
Potential Health (Non-carcinogenic) Risk	Calcium				
	Magnesium				
	Iron				
	Manganese				
	Zinc				
	Chromium				
Prevalent water-related illnesses	Malaria				
	Typhoid fever				
	Diarrheal diseases				
	Gastro-intestinal tract infection				
	Upper respiratory tract infection				
	Pelvic inflammatory disease/Urinary Tract Infection				
	Skin infections				

4
3
2
1
Not applicable

Differential outlook of water quality, WASH/MHM practices, and Health impacts in Abeokuta City, Nigeria.

This preliminary assessment of water quality and gender dynamics indicates a profound inadequacy in accessing WASH services within the pilot study area, raising considerable doubts about achieving SDG 6 by 2030. Without point-of-use treatment and appropriate water safety protocols, the water sources are unsuitable for potable uses, potentially posing compounded health risks associated with hardness and high calcium content, particularly affecting boys. Girls are likely the most affected by the repercussions of water collection, including time constraints, health implications, and safety concerns. Men and boys face a higher risk related to poor hygiene, while women may be more susceptible to health effects stemming from toilet cleaning responsibilities and shared sanitation facilities. Despite the preference for disposable sanitary pads among most women and girls, women change more frequently and adopt better menstrual hygiene practices than girls. The persistence of poor menstrual hygiene among girls may pose substantial health risks in the near and distant future. Enhancing women's economic status could improve access to superior healthcare services and significantly elevate household well-being. Overall, the study underscores the gendered impacts of unsafe water, inadequate WASH services, and practices on human health and well-being, emphasizing that gendered statistics through sex-disaggregated data are crucial to uncover the often-masked differential impacts, which are not gender-neutral or evenly distributed across age groups.



Women waiting for water. *Photo: Flickr/Abdon Awono/CIFOR/CC BY-NC-ND 2.0*

Introduction



African women fetching water from outside. *Photo: Freepix*

Differential Impact Assessment (DIA) generally refers to the examination of the varying effects of a particular phenomenon, policy, or intervention on different populations, groups, or geographic areas. It aims to identify and understand how the impacts or outcomes differ across these different entities, including accentuating the relevance of gender and age groups, as shown in this report.

Over the years, the concept of gender, perceived as a social construct typically described in femininity and masculinity [1], has transcended bilinear sexual identities to multi-sexual identities that include the transgender or LGBTQIA. The absence of documented reviews of impacts on almost anything on the LGBTQIA in the public domain may have however limited impact-related discourse to the bilinear sexual identities of women and men. Research on transgender is still in the early stages due to social stigma, lack of funding, lack of awareness, and complexity of the topic. Transgender research is complex, and much is still unknown about the transgender experience, making it difficult to design and conduct research studies that can provide definitive answers [2]. Ongoing debates on social inclusion are, however, crucial to ensure all identified gender groups are included in monitoring and evaluation to align with the global agenda of "…leave no one behind' [3], [4]. Agreeably, the construct of gender in this report is not a shorthand for women [5]. Likewise, the interplay of gender and water does not connote the need to address only female vulnerability but to identify and understand differential impacts for apt gendered actions.

In the water sector, recognition of the link between unsafe water and public health is dated. Water is the primary transmission route of pathogens and chemicals to millions of people due to its unique attribute (universal solvent) to dissolve all/almost anything in its path. The consequences of this unique nature are morbidity and mortality of millions yearly from diseases associated with water. This association, generally defined as water-related infectious diseases – WRID [6] varies from water-borne (Ingestion of pathogens in contaminated water e.g., typhoid) to water-washed (Poor hygiene/lack of access to safe water e.g., diarrheal diseases), water-based (Infection by agents that spend part of their life cycle in water e.g., schistosomiasis), and water-related vectors (Spread by vectors that breed or bite near water, e.g., malaria). In 2022, diarrheal diseases and malaria remained among the top 10 causes of death globally [7].

Many studies have examined the water-public health nexus, documenting how unsafe water affects public health and how poor WASH practices elevate the risk of WRID [8]-[10]. Other areas of interactions between unsafe water and public health/socioeconomic effects that attracted attention over the years are the impact assessment of anthropogenic actions and water events like extremes due to climate change, on water quality. The former highlighted domestic, agricultural, and industrial activities and poor waste management as eminent human-caused sources of water contamination [11]-[13], the impacts of unending climate change on water quality range from increasing human pathogens like *mycobacterium avium* in drinking water distribution systems because of low-pH conditions from absorption of large amounts of carbon dioxide from extremes like floods to increasing risk of microorganism nourishment due to a high-water temperature from rising global warming [14]. These suggest that extremes due to climate change affect not only water quantity and quality [15] but also human health and socioeconomic well-being. Some other studies reviewed the intersections of health on the water and gender interlinkages [16], emphasizing that addressing gender and water inequities holds the potential to alleviate disease burden. Some also explored the influence of water-related (WASH- water, sanitation, and hygiene and MHM – menstrual hygiene management) factors on health issues specific to women, men, boys, and girls e.g., the prevalence of reproductive tract infections (RTIs) among reproductive-age women [17].

Generally missing, however, are studies into holistic gendered impacts. Innuendoes like "climate change-induced water quality and natural events affect men and women differently…" are common but how differently? The extent or magnitude of such differences is rarely quantified. Similarly, while the influence of unsafe water on health is known, the extent of reported cases due to men, women, boys, and girls are often not the focus of evaluation nor well-documented. Since the start of the global Sustainable Development Goals (SDG) era in 2015, monitoring of WASH services has primarily targeted the general population, e.g., SDG 6.1, 6.2a, and 6.2b - "The proportion of the population using safely managed drinking water and sanitation services/handwashing facilities with soap and water at home" respectively [16]. More than halfway through the era end-date of 2030, monitoring of differential access to WASH services or its impact analysis is limited. In all suggesting that differential impacts analysis is often unrecognized as an essential connecting factor to minimize the effects of water-related issues like water quality deterioration on health/socioeconomic well-being.

As part of its Strategy 2020-2024, The United Nations University Institute for Water, Environment and Health

(UNU-INWEH) initiated an investigation into the interplay between water quality, WASH, and gender. This analysis examines distinct variables of water quality and their varying impacts on gender like reported water-related illnesses of males and females, and the consequences of water quality, sanitation, and hygiene on menstrual hygiene practices, particularly focusing on low- and middle-income countries (LMICs). The aim is to understand the diverse impacts and gender-specific risks associated with declining water quality and managing water, sanitation, and hygiene. The objectives align with the call by the SDG 3 to address health priorities including reproductive, maternal, and child health, SDG 5 to attain gender equality and empower women and girls, and SDG 6 to ensure universal access to safe water and sanitation. In addition, the initiative calls for expanding scientific monitoring of sex-disaggregated data in the water domain to uncover the often-ignored or strategically dismissed linkages between water and gender for effective and fit-for-purpose management of water resources based on their quality.

This report presents the key findings from the study [18], outlining a framework and guidance for examining gender-specific impacts stemming from poor water quality and WASH practices through a piloted case study in Abeokuta City, Nigeria, to serve as a preliminary guide for conducting comprehensive, site-specific assessments. The piloted assessment framework is a 5-step approach, guiding the evaluation of gendered impacts from method design to the field activities, which include water sampling and laboratory analysis, public survey, and health data collection, to the data and gender analysis, hoping it will equip professionals across water, climate, gender, health, and related disciplines and sectors with the tool to assess location-specific gendered impacts of unsafe water. The focus on low- and middle-income countries underscores the importance of DIA in such regions for better health and socioeconomic outcomes. This report also discusses the lack of a standardized protocol for monitoring sex-disaggregated data, shedding light on the unseen global-scale gendered impacts of unsafe water. It further provides information on addressing the observed gendered impacts of unsafe water on health and well-being in the study area and by extension to areas with similar characteristics. It targets policymakers, and donor organizations advocating for sustainable water resource development, public health, human rights, and those promoting gender equality to enhance global, regional, national, and community-level water management. A particular but non-exhaustive list of actors include:

- International and UN agencies focusing on global health (e.g., World Health Organization - WHO, United Nations Children's Fund - UNICEF); water and sanitation (e.g., UN-Water); collection, monitoring and reporting of water data (e.g., UNESCO WWAP, Demographic and Health Survey Program); mainstream gender equality and women empowerment (e.g., UN Women, Organization for Economic Co-operation and Development - OECD); water education (e.g., UNESCO-IHE Institute for Water Education) and water governance (e.g., UN Human Rights Council - UNHRC); and promote political awareness and actions e.g. World Water Council).
- International and Regional organizations that support and promote foreign direct investment into developing countries to support economic growth and reduce poverty (e.g., World Bank, African Development Bank - AfDB).
- Governmental and private organizations responsible for potable water supply (e.g., Water and Sanitation Ministries, State Water Boards); regulating water quality (e.g., National Agency for Food and Drug Administration and Control - NAFDAC); and monitoring health issues (e.g. Nigeria Centre for Disease Control - NCDC, Hospital Management Boards - HMB).
- Non-governmental organizations working with other health actors on the ground to address important water and health issues in the poorest communities (e.g., WaterAid).

[1] Nanda, S. (2019). The Dynamics of Culture and Gender: Reflections in English Literature. Motifs: An International Journal of English Studies. https://doi.org/10.5958/2454-1753.2019.00006.0

[2] Scheim, A., Kacholia, V., Logie, C., Chakrapani, V., Ranade, K., & Gupta, S. (2020). Health of transgender men in low-income and middle-income countries: a scoping review. BMJ Global Health, 5. https://doi.org/10.1136/bmjgh-2020-003471

[3] George, G., Baker, T., Tracey, P., & Joshi, H. (2019). Inclusion and innovation: a call to action. Handbook of Inclusive Innovation. https://doi.org/10.4337/9781786436016.00008

[4] United Nations. (2017). Leaving No One Behind: Equality and Non-Discrimination at the Heart of Sustainable Development. *The United Nations System Shared Framework for Action*, 1-84. https://unsceb.org/sites/default/files/imported_files/CEB%20equality%20framework-A4-web-rev3.pdf

[5] Das, B. (2017). A New Look at Water and Gender. https://documents.worldbank.org/curated/en/901081503580065581/pdf/119074-WP-P164939-PUBLIC-23-8-2017-17-59-55-W.pdf

[6] Bartram, J., Baum, R., Coclanis, P. A., Gute, D. M., Kay, D., Mcfadyen, S., Pond, K., Robertson, W., Rouse, M. J., Bartram, J., & Hunter, P. (2023). Routledge Handbook of Water and Health Bradley Classification of disease transmission routes for water-related hazards. https://doi.org/10.4324/9781315693606.ch03

[7] WHS. (2022). World health statistics 2022 (Monitoring health of the SDGs). In Monitoring health of the SDGs. http://apps.who.int/bookorders

[8] Alshareef, H. (2021). The Effect of Water, Sewage and Hand Hygiene on Waterborne Diseases in Saudi Arabia. https://www.diva-portal.org/smash/get/diva2:1616138/FULLTEXT01.pdf

[9] Geere, J. A. L., Cortobius, M., Geere, J. H., Hammer, C. C., & Hunter, P. R. (2018). Is water carriage associated with the water carrier's health? A systematic review of quantitative and qualitative evidence. BMJ Global Health, 3(3), 1–24. https://doi.org/10.1136/bmjgh-2018-000764

[10] Li, P., & Wu, J. (2019). Drinking Water Quality and Public Health. Exposure and Health, 11(2), 73–79. https://doi.org/10.1007/s12403-019-00299-8

[11] Barzegar, R., Asghari Moghaddam, A., & Tziritis, E. (2016). Assessing the hydrogeochemistry and water quality of the Aji-Chay River, northwest of Iran. Environmental Earth Sciences, 75(23). https://doi.org/10.1007/s12665-016-6302-1

[12] Mgbenu, C. N., & Egbueri, J. C. (2019). The hydrogeochemical signatures, quality indices and health risk assessment of water resources in Umunya district, southeast Nigeria. Applied Water Science, 9(1), 1–19. https://doi.org/10.1007/s13201-019-0900-5

[13] Tziritis, E. P., Datta, P. S., & Barzegar, R. (2017). Characterization and Assessment of Groundwater Resources in a Complex Hydrological Basin of Central Greece (Kopaida basin) with the Joint Use of Hydrogeochemical Analysis, Multivariate Statistics and Stable Isotopes. Aquatic Geochemistry, 23(4), 271–298. https://doi.org/10.1007/s10498-017-9322-x

[14] Ma, B., Hu, C., Zhang, J., Ulbricht, M., & Panglisch, S. (2022). Impact of Climate Change on Drinking Water Safety. ACS Environmental Science and Technology Water, 2(2), 259–261. https://doi.org/10.1021/acsestwater.2c00004

[15] Mishra, A., Alnahit, A., & Campbell, B. (2020). Impact of land uses, drought, flood, wildfire, and cascading events on water quality and microbial communities: A review and analysis. Journal of Hydrology, 125707. https://doi.org/10.1016/j.jhydrol.2020.125707

[16] Pouramin, P., Nagabhatla, N., & Miletto, M. (2020). A Systematic Review of Water and Gender Interlinkages: Assessing the Intersection with Health. In Frontiers in Water (Vol. 2, Issue April). https://doi.org/10.3389/frwa.2020.00006

[17] Ademas, A., Adane, M., Sisay, T., Kloos, H., Eneyew, B., Keleb, A., Lingerew, M., Derso, A., & Alemu, K. (2020). Does menstrual hygiene management and water, sanitation, and hygiene predict reproductive tract infections among reproductive women in urban areas in Ethiopia? PLoS ONE, 15(8 August 2020), 1–15. https://doi.org/10.1371/journal.pone.0237696

[18] Oluwasanya, G., Omoniyi, A., Perera, D., Layi-Adigun, B., Thuy, L., & Qadir, M. (2023). Water quality, WASH, and gender: differential impacts on health and well-being in Abeokuta City, Nigeria. Environmental Monitoring and Assessment, 195(10), 1-22. https://doi.org/10.1007/s10661-023-11833-2



Girls carry buckets filled with water in Nigeria. *Photo: UNICEF/Rich/UNI182020*

Absence of standardized protocol for monitoring sex-disaggregated data

The lack of a consistent and universally agreed-upon method or set of guidelines for collecting data that is divided by sex (referred to as sex-disaggregated data) serves as the foundation for hidden or unnoticed gender-based impacts on a global scale. Essentially, without a standardized protocol for systematically collecting and differentiating data based on gender, various effects and consequences that affect different genders disproportionately remain largely overlooked. While actual quantitative evidence is crucial to highlight the extent or magnitude of water-related differential impacts and the gender footprint in the management of such impacts, assessing gendered impacts on a wide scale may be restrictive.

Primary factors limiting global scale differential impacts analysis include one, more, or a combination of the following reasons:

Data scarcity:
The lack of reliable and accurate data on about anything in essentially low-resource regions, especially sub-Saharan Africa, is well known, making it difficult to establish robust correlations and identify specific causal relationships between poor water quality and its outcomes.

Complexity of causal pathways:
Water quality interacts with various other factors such as sanitation, hygiene practices, access to healthcare, socioeconomic disparities, and societal norms/culture making it challenging to isolate the direct impact of water quality alone.

Contextual variations:
The impact of poor water quality can vary significantly depending on geographic location, demographic characteristics, and gender differences due to physiological composition, age marginalization, socioeconomic conditions, disability, and restrictive social norms and cultural practices that constantly put women and children at a disadvantage through performative actions. Analysing these contextual variations requires a nuanced approach, considering regional disparities, urban-rural divides, and specific demographic vulnerabilities, which adds complexity to the analysis.

Long-term effects and latency period:
Some health and socioeconomic effects of poor water quality may not be immediately apparent but can manifest over a longer period. Identifying and quantifying these long-term effects requires longitudinal studies and robust data collection methods, posing logistical and resource challenges.

Confounding factors and interdependencies:
Poor water quality often coexists with other environmental, social, and economic challenges. Disentangling the effects of poor water quality from these confounding factors and understanding their interdependencies is a significant challenge. Factors such as poverty, inadequate sanitation, pollution, and lack of education can all contribute to poor health outcomes and socioeconomic disparities.

Ethical considerations:
Analysing differential impacts of vulnerable populations requires ethical considerations. Protecting the rights and privacy of participants, navigating sensitivities, ensuring equitable representation, and avoiding further harm or stigmatization are essential aspects to be addressed.

Overcoming these challenges requires real-time primary sex-disaggregated data sourcing, interdisciplinary collaboration among experts (e.g., public health, environmental science, economics, sociology, and policymaking), and aggregation of local-specific primary data to promote and improve gendered outcomes on a global scale. This points to the need for a standardized methodology for collecting sex-disaggregated data, a guide for assessing site-specific differential impacts to encourage evidence-based gender-appropriate WASH, health, and socioeconomic actions to address the differential impacts of poor water quality for better health and inclusive water management. However, so far, no studies have holistically quantified health and socioeconomic well-being disparities due to unsafe water and WASH or prescribed a data monitoring and assessment instrument or protocol for the same, particularly in the low- and medium-income countries (LMIC).

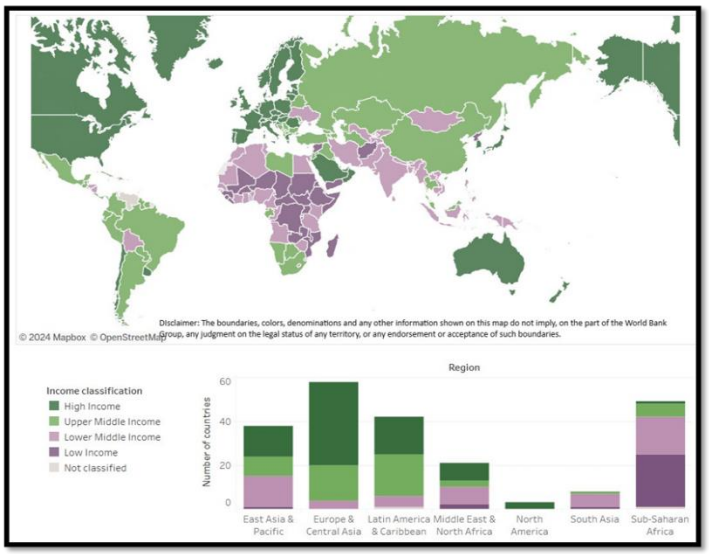
Why focus on a low-and middle-income country?

Blindsiding differential impact monitoring and analysis is recurrent across sectors and at scales; local to global, particularly in the LMIC. A systematic review of water and gender interlinkages in the LMIC reported a few studies directly compared gender dimensions in accessing WASH resources on health intersections, and an even smaller fraction (8.5% of 59 studies) described sex-disaggregated outcomes [16].

Nigeria, in sub-Saharan Africa, is the 32nd largest country in the world and the 5th most populous nation in the LMIC with a total population of 220,291,275, a male: female ratio of 50.5%: 49.5% [19], total land area of 923,770 km2 [20] and is bordered by four countries, including Benin, Niger, Chad, and Cameroon. With a GDP per capita of 2,066 USD, the country holds significant growth potential due to its abundant natural resources (land, water, forest), large human population, and geographical and hydrological features. However, Nigeria's water resource faces threats ranging from climate-induced extremes (floods and droughts) to pollution from industrial and agricultural activities, uncontrolled urbanization, conflicts, poor governance, and an increasing population growth rate (+2.4%), resulting in a decline in water availability per capita [21]. The country ranked 22nd among 54 African countries in terms of water security [22] and rated water insecure in the Global Water Security Outlook 2023 [23] – suggesting Nigeria's position in both rankings is poor with a huge opportunity for improvement to be water secured.

The country grapples with other challenges, including economic fragility, limited financial resources for infrastructure development, and subsequent inadequacies in meeting fundamental human necessities. A considerable proportion of the population - about 60, 80, and 167 million are without access to drinking water, improved sanitation services, and basic WASH facilities, respectively [24]. Compounding these challenges is the nation's weak institutional capacity, characterized by deficiencies in technology, resources, and policy/governance frameworks. The inadequacies in governance are further manifested in the unreliability and unaffordability of WASH services, and deficiencies in associated health infrastructure development [22]. These factors collectively contribute to stark inequalities in access to fundamental human needs and services, underscoring the pressing need for robust and inclusive interventions to address Nigeria's water and sanitation disparities.

Historically, the highlighted national issues and threats portray the challenges common to countries not only in sub-Saharan Africa but all or most developing nations with resultant impacts on human health and well-being. Contrary to the assumed, these impacts are not gender-neutral; they affect women, men, girls, and boys differently due to inequalities caused by physiological composition, age marginalization, socioeconomic conditions, disability, and restrictive social norms that constantly put women and children at a disadvantage through performative actions. Given these historic vulnerabilities, exacerbated by increasing climate change impacts, the LMIC presents a huge opportunity for differential impact monitoring and assessment to get measurably better health and socioeconomic outcomes.



World Bank country classification by income level GNI per capita in US$ (Atlas methodology)



A view of Abeokuta city, Nigeria. *Photo: Wikimedia Commons/Omeko media, CC BY-SA 4.0*

[16] Pouramin, P., Nagabhatla, N., & Miletto, M. (2020). A Systematic Review of Water and Gender Interlinkages: Assessing the Intersection with Health. In Frontiers in Water (Vol. 2, Issue April). https://doi.org/10.3389/frwa.2020.00006

[19] United Nations. (2022). World Population Prospects 2022 Data Sources (Issue 9). https://www.un.org/development/desa/pd/content/World-Population-Prospects-2022

[20] FAO. (2016). AQUASTAT Country Profile - Nigeria. Food and Agriculture Organization of the United Nations Rome Italy, 1–20. http://www.fao.org/countryprofiles/index/en/?iso3=NGA

[21] Ngene, B. U., Nwafor, C. O., Bamigboye, G. O., Ogbiye, A. S., Ogundare, J. O., & Akpan, V. E. (2021). Assessment of water resources development and exploitation in Nigeria: A review of integrated water resources management approach. In Heliyon (Vol. 7, Issue 1, p. e05955). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2021.e05955

[22] Oluwasanya, G., Perera, D., Qadir, M., & Smakhtin, V. (2022). Water Security in Africa: A Preliminary Assessment. In United Nations University Institute for Water, Environment and Health, Hamilton, Canada. https://reliefweb.int/report/niger/water-security-africa-preliminary-assessment%0Ahttps://inweh.unu.edu/publications/

[23] MacAlister, C., Baggio, G., Perera, D., Qadir, M., Taing, L., Smakhtin, V. (2023). Global Water Security 2023 Assessment. United Nations, University Institute for Water, Environment and Health, Hamilton, Canada. https://inweh.unu.edu/wp-content/uploads/2023/04/23-116_UNU_Water_Security_WEB_Final_updated.pdf

[24] Bello, N. I., Abubakar, A. S., Adamu, H., & Bello, A. (2023). *Status of Water Supply and Sanitation in Hadejia Local Government, Jigawa State, Nigeria*, *23*(6). https://journalspress.com/LJRHSS_Volume23/Status-of-Water-Supply-and-Sanitation-in-Hadejia-Local-Government-Jigawa-State-Nigeria.pdf

The State of Water Quality, Sociodemographic/Economic and WASH Factors as Basis for Gendered Disparities of Health Impacts and Well-being

Water Quality and Health Considerations

The pilot study examined the water quality of the four major water sources (HDW, BH, STW, and SW) in Abeokuta City to highlight potential contaminants, pollutants, or natural elements influencing health conditions. Figure 1 revealed that water samples from all four sources were slightly acidic, with pH values ranging between 6.3 ± 0.2 and 6.9 ± 0.2. Both HDW and STW had pH values (6.3) that were lower than the acceptable range of 6.5-8.5 [25]. Electrical conductivity, a measure of the enrichment of ions (particles with net electric charge) in water, varied considerably between 82 and 860 µS/cm, but it remained well within the standard threshold of 1000 µS/cm, indicating a Type I (low ion enrichment) conductivity classification. Higher levels of total dissolved solids (> 500 mg/L) in drinking water are frequently linked to diarrheal and abdominal pain [26] but all the water samples contained dissolved solids below 500 mg/L (considered freshwater category), with concentrations in the order HDW > BH > SW > STW.

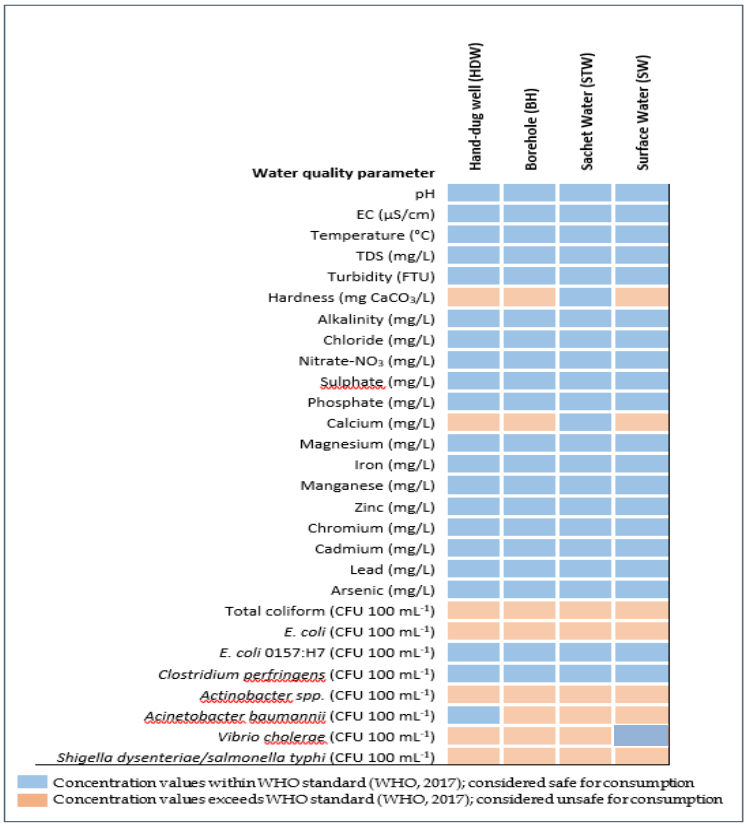


Figure 1. The state of water quality in Abeokuta City, Nigeria

Turbidity values were generally lower than the standard 5 NTU, except for SW (5.8 ± 4.1 NTU). Every water sample, except for STW, had hardness levels above 200 mg $CaCO_3$/L (i.e., hard water) in the order of BH > SW > HDW. Hard water minerals can alter the pH balance of human skin, making it less effective as a barrier against pathogenic bacteria and skin conditions like eczema and skin irritation [27]. The chloride and alkalinity concentrations were less than the suggested values of 250 mg/L and 120 mg/L, respectively [25]. The concentrations of nitrate-NO_3, sulphate, and phosphate met the WHO allowable limits - these are essential dietary anions for humans but the source of algae growth in water bodies. Calcium is a crucial element for human health, but all sources except STW had higher levels of calcium than the WHO's 75 mg/L threshold. However, the average concentrations of iron, chromium, cadmium, magnesium, manganese, and zinc, were all significantly below the WHO recommended limits in all the water sources, including arsenic and lead, which were below the maximum detection limit.

Results of microbial analysis of the water samples further reveal three opportunistic (*Vibrio cholerae, Acinetobacter baumannii, and Actinobacter spp.*) pathogens, two enteric (*Escherichia coli and Shigella dysenteriae/salmonella typhi*) pathogens, and total coliforms, while neither *Clostridium perfringens* nor *Escherichia coli 0157:H7* were found (Figure 2). Total coliforms (0.002 – 1.5×10^{-1} CFU 100 mL^{-1} of water) were detected in 18 (51%) of 35 water samples, occurring more in STW samples (6 samples out of 10) and least in HDW (3 samples out of 10). Although total coliform bacteria are unlikely to be harmful, their presence in drinking water suggests that other potentially harmful organisms may be present. *Shigella dysenteriae/salmonella typhi*, which frequently causes watery/bloody diarrhoea and stomach pain in humans, was found in 31% (n = 11) of 35 water samples. The bacteria's CFU 100 mL^{-1} ranged from 0.004 to 1.96×10^{-1} with maximum incidence (6 of 10) in borehole samples. Also, most of the records for *Escherichia coli*, an enteric pathogen linked with sepsis, pneumonia, bloody diarrhoea, and UTIs, came from boreholes. The detection levels of this pathogen ranged from 0.002 to 8.4×10^{-2} CFU 100 mL^{-1}.

Acinetobacter baumannii (0.006 – 4.2×10^{-2} CFU 100 mL^{-1}) from BH and SW was found in 9% (n = 3) of the water samples, while both *Actinobacter spp*. (0.001 – 2.4×10^{-2} CFU 100 mL^{-1}) from all four water sources and *Vibrio cholerae* (0.004 – 1.8×10^{-2} CFU 100 mL^{-1}) from BH, HDW, and SW were found in 11% (n = 4) of the samples. Specifically, *Vibrio cholerae*, which is commonly recognized as the causative agent of cholera infection, has the capacity to initiate a large widespread but generally contained outbreak (epidemic) with the potential to spiral into an international out of control spread (pandemic) and even consistently persist (endemic) in all affected areas [28]. Additional genomic analysis through amplification on the most detected isolates showed more opportunistic pathogens (*Klebsiella spp.*, *Enterobacter spp.*, *Citrobacter spp.*, and *Salmonella enterica*) in all the water sources, except for the STW samples.

Socio-demographic and economic profiling of the individuals involved in the study

The research examined the sociodemographic and economic disparities of the individuals involved in the study to highlight and better understand inequality of the gendered impacts. Table 1 reveals a breakdown based on gender, age groups, marital status, educational attainment, wealth classification, and occupation. It further shows the number of individuals involved in the study, 456 participants; 129 (28%) were women, 112 (25%) were men, 107 (23%) girls, and 108 (24%) were boys.

Their ages varied, with 49% being adolescents (12 to 18 years old), individuals in the productive age range (19 to 60 years) at 48%, and the elderly (above 60 years) at 3%. Three hundred and one (301, 66%) of the individuals were unmarried, 146 (32%) were married, 5 (1%) were widowed, and 4 (about 1%) were separated. Only 4% of those involved in the study had no formal education, the majority (96%) had completed secondary education (73%), primary education (13%), and higher education (10%). Though 176 (38%) of the people did not report their wealth status, 173 (38%) were classified in the lower economic class (below the national minimum wage of 33,000NGN or less than 70 USD per month), 81 (18%) in the lower-middle class, 18 (4%) in the middle class, and 8 (2%) in the high economic class. In terms of occupation, 216 (47.5%) of the participants were business owners/artisans, 208 (45.7%) were of schooling age, 14 (3.1%) were unemployed, 12 (2.6%) were civil servants, and 5 (1.1%) did not report their occupation. The highlighted distribution of individuals across the presented categories points out the diversity and disparities within the studied population, shedding light on the multifaceted aspects of inequality, particularly regarding gendered impacts. The statistics presented underscore the importance of considering various demographic and economic factors when assessing and understanding disparities in the effects of water-related actions and events.

Table 1: Socio-demographic and economic characteristics of the study participants in Abeokuta City, Nigeria

Variables	Frequency n(%)	Variables	Frequency n(%)
Age in years		**Educational status**	
12 to 18	224(49)	No formal education	17(4)
19 to 45	187(41)	Primary	61(13)
46 to 60	33(7)	Secondary	330(73)
> 60	12(3)	Above secondary	46(10)
Gender by age in years		**Occupation**	
Female: Adult >18	129(28)	Schooling	208(45.7)
Female: Child < 18	107(23)	Civil servant	12(2.6)
Male: Adult > 18	112(25)	Business owners (Artisans/Trading)	216(47.5)
Male: Child < 18	108(24)	Unemployed	14(3.1)
Marital status		Others	5(1.1)
Single	301(66.0)	**Wealth index**	
Married	146(32.0)	Lower economic class	173(37.9)
Widowed	5(1.1)	Lower-middle economic class	81(17.8)
Separated	4(0.9)	Middle economic class	18(3.9)
		High economic class	8(1.8)
		Undisclosed economic status	176(38.6)

Disparities based on WASH and Health-related characteristics and management practices

Beyond investigating the components of the water quality affecting health through water sources, the study examined how characteristics and management practices concerning WASH and health considerations could have gender-specific implications. The study explored a) attributes associated with drinking and domestic water provisions, b) Sanitation and hygiene-related characteristics, and c) Gendered WASH practices.

Detailed information about the study method and analysis components can be found in Appendix I.

For attributes associated with drinking and domestic water provisions: More than half of the survey participants, 269 (59%), indicated packaged water (sachets-STW) as their primary source of water for drinking (Figure 2). Communal boreholes were reported by 122 respondents (26.8%), while 33 individuals (7.2%) mentioned hand-dug wells. In-house connections constituted the main drinking water source for 17 participants (3.7%), rainwater for 13 (2.9%), and surface water for 2 (0.4%) individuals. For cooking, 252 respondents (55.3%) identified communal boreholes as their primary water source. Hand-dug wells were reported by 149 participants (32.7%), in-house connections by 47 (10.3%), surface water by 6 (1.3%), and rainwater by 2 individuals (0.4%). For domestic activities, 252 respondents (59.7%) cited hand-dug wells as their main water source. Communal boreholes were reported by 122 individuals (29%), rainwater by 28 (6.6%), in-house/reservoir connections by 10 (2.4%), packaged water by 9 (2.1%), and surface water by 1 person (0.2%). 186 individuals (49%) of the study participants reported using less than 20 L of water per day, while 127 (33.4%) used between 21 and 50 L per day, and 67 (17.6%) used over 50 L per day. Of the study participants, 394 (86%) did not treat their water source for drinking purposes, leaving only 62 individuals (14%) who employed various treatment methods, with 58% resorting to boiling, 12.9% using household hypochlorite for disinfection, 11.3% settling without chemicals, 9.7% utilizing alum, 6.5% employing filtration, and 1.6% adopting a mixed method involving two or more outlined techniques. Similarly, about 417 participants (91%) did not treat their water for domestic activities. Only 39 individuals (9%) implemented various treatment techniques, including 33.3% boiling, 33.3% disinfection, 23% use of alum, 5% hiring experts for routine annual treatment, 2.6% filtration, and 2.6% settling without chemicals.

Sanitation and hygiene-related characteristics: The study revealed that many of the participants, specifically 333 individuals (73%), utilized flush toilets, while 117 individuals (25.7%) relied on latrines (Figure 2). Only a small number, 6 individuals (1.3%), resorted to open defecation. However, only 38% of respondents reported that sanitary facilities are located over 30 meters (considered a safe distance) from a water source. Most (52%) of them, claimed 6–30 meters, and 10% reported an unsafe distance of less than 5 meters. Examining the proximity of water sources to other potential threats such as solid waste dumps and burial sites, a majority (61%) asserted a safe distance of over 30 meters, 30% acknowledged 6 to 30 meters, and 9% reported an unsafely close distance of less than 5 meters. Sanitation services considered as "safely managed" – the key indicator for SDG 6.2 – entail using improved facilities not shared with other households, along with other requirements like safe excreta disposal in-situ. Assessing the compliance with safely managed sanitation services, only 2% of participants did not share sanitation facilities with other households. The majority (98%) reported sharing a facility with 1-3 households (30%), 4-10 households (51%), and over ten households (17%). The prevalence of sharing with 4-10 households can be attributed to the common housing style that accommodates multiple households. As for the cleaning practices of sanitation facilities, a small percentage of participants (0.2%) used water alone, while 28.7% used soap and water. Additionally, 40.8% cleaned with water and disinfectant only, and 30.3% used a combination of water, soap, and disinfectant. Eight participants (1.8%) reported cleaning the facility on demand, while 25.9% cleaned at least once a day, 54.4% at least once a week, and 17.9% more than twice a week.

In terms of hygiene characteristics, only 21.3% (97 participants) had access to a handwashing facility with soap and water, considered the best practice. 4.8% (22 participants), had access to a handwashing facility without soap, while the majority – 73.9% (337 individuals) had no access to a handwashing facility. Among the 119 participants with the handwashing facility, 69% wash their hands on demand, 14% once daily, 15% at least twice daily, and 2% occasionally.

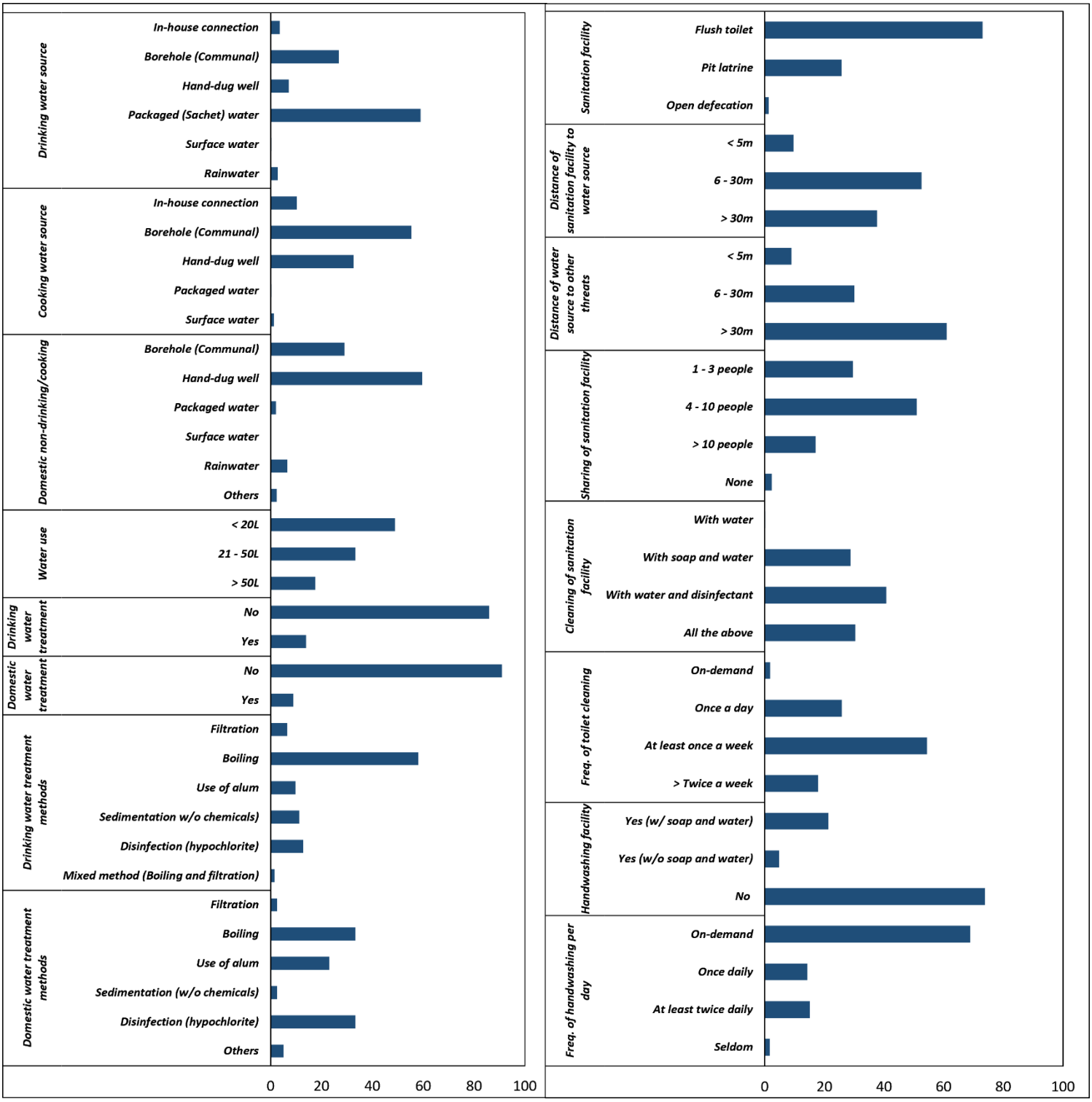


Figure 2. Water, Sanitation, and Hygiene-related characteristics/practices among the study participants in Abeokuta City, Nigeria

Gendered WASH practices: Figure 3 also highlights the gendered disparities in water-related responsibilities and hygiene practices. As anticipated, the reported water collection responsibilities reflect a higher burden on children and women compared to men as findings show water collection disparity percentages of 23.7% (108 girls), 23% (104 boys), 21% (95 women), and only 8% (38) of the men. This left 20.5% (93 individuals) relying on anyone available, 2.4% (11 people) practicing shared responsibility (e.g., between children and adults), and 3 people each, about 1 percent (0.7%) utilizing outsourced and in-house connections. The task of toilet cleaning is more likely on women (47%) and girls (15%) than men (5%), and boys (4%), substantiating the widely accepted socially constructed gender roles in households. Additional responses indicate that 15% of the individuals relied on anyone available, 12% claimed shared responsibility, and 2% outsourced toilet cleaning. For hygiene practices, 414 participants (comprising 30% women, 24% girls, 23% men, and 23% boys) reported practicing hand washing after toileting, while 42 participants (38% men, 26% boys, 19% girls, and 17% women) do not adhere to handwashing after toileting. Indicating that a notable proportion of male gender participants do not adhere to handwashing practices after using the toilet. All these findings underscore the unequal division of labor and hygiene practices across genders.

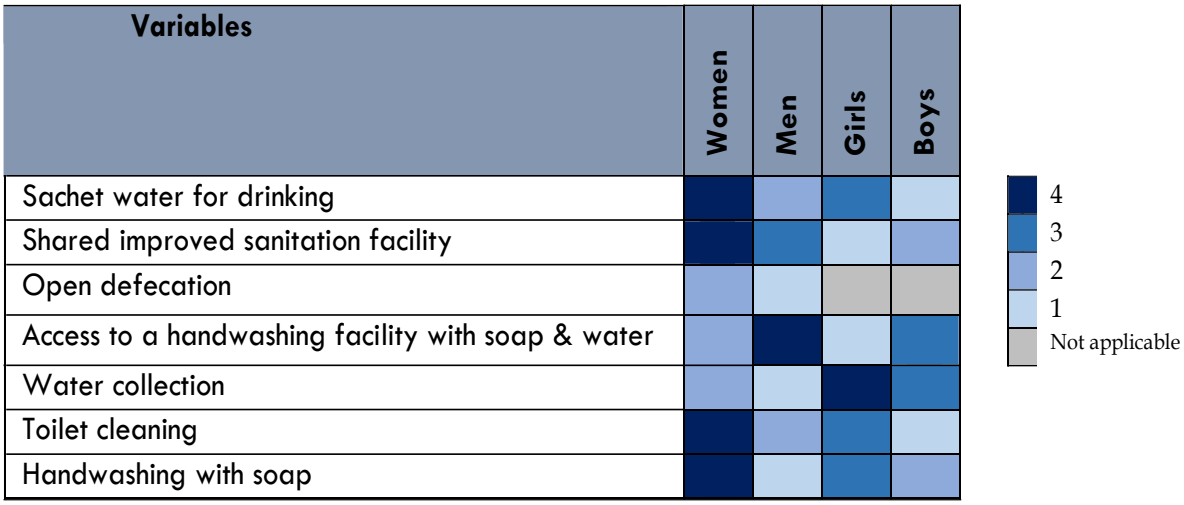


Figure 3. Differential outlook of water quality and WASH practices in Abeokuta City, Nigeria

Differences based on health-related practices and culture

Further investigation into health behaviors and related cultural practices provided insights into healthcare decisions and preferences among the study participants. Figure 4 highlights that a significant majority (68%) opt for self-healthcare sponsorship, while approximately one-third (32%) rely on third-party support for healthcare (e.g., parents, government/private insurance). Notably, women tend to take charge of household healthcare decisions more frequently (60%) compared to men (35%) and boys (1%), who generally manage their healthcare independently. Additional responses like adults of either gender (3%) or both adults (1%) jointly made healthcare decisions, are a minority.

In terms of healthcare facility preferences, the majority (23%) reported private secondary facilities, followed by pharmacies (18%), primary healthcare centres (15%), and Homecare (14%). Self-medication (8%), traditional methods (7%), public secondary facilities (6%), and tertiary facilities (5%) were less frequently selected. The least common options, however, include mixed approaches combining pharmacy and primary healthcare centres at (3%), and both sleep therapy and application of faith each at 1%.

Figure 4 further illustrates gender disparities in healthcare facility utilization, with more women (31%) than men (23%), and more boys (33%) than girls (13%) preferring private secondary health facilities. Also, more women (24%) than men (19%) and more girls (39%) than boys (18%) patronize pharmacies for their healthcare needs. Conversely, more men (32%) and boys (28%) utilize primary healthcare centers compared to women (22%) and girls (18%). Additionally, more men (34%) than women (17%) and more boys (29%) than girls (20%) use self-medication. These findings demonstrate diverse healthcare-seeking behaviors across genders and highlight the prominence of various healthcare options, emphasizing the need to address these differences.

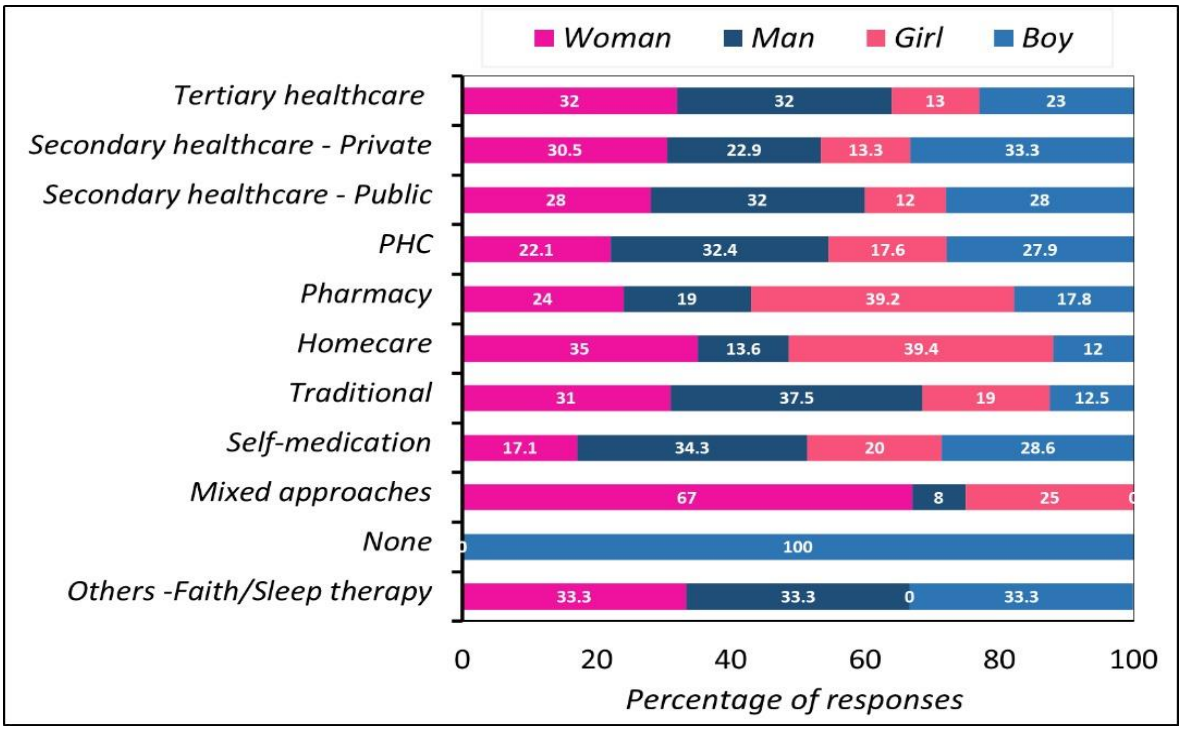


Figure 4. Gendered Health culture/practices among the study participants in Abeokuta City, Nigeria

Differential practices related to the management of menstrual hygiene

To see how water quality and WASH practices further interrelate with gender, the study delved into menstrual hygiene practices among the female study participants. The results showed that all 233 female participants used blood-absorbent materials during menstruation, with the majority (149 individuals, comprising 52% women and 48% girls) choosing disposable sanitary pads (Figure 5). 57 participants (46% women, 54% girls) utilized a combination of absorbent materials, including both disposable and reusable options. Using alternative blood-absorbent materials, such as cotton wool, mattress/foam, period underwear, tampons, toilet tissue paper, and underwear alone, was relatively low.

The frequency of changing absorbent materials varied; most (219/94%) changed at least twice daily. Only a small fraction (6%), comprising more girls- 64% than women- 36%, changed their materials once daily. Participants who changed materials at least twice daily, 110 (more girls- 56% than women- 44%) changed twice a day, while the remaining 109 females (more women- 62% than girls- 38%) changed more than twice a day – suggesting women may exhibit better menstrual cleanliness.

Still on menstrual hygiene, most (151) of the female participants; more women (54%) than girls (46%), indicated that they washed their hands before changing absorbent materials, but 82 females, conversely more girls (51%) than women (49%) reported not washing their hands before changing sanitary materials. Also, the majority (225/97%), comprising more women (120/53%) than girls (105/47%), practiced handwashing after changing menstrual materials, while only 8 females (3%) did not engage in handwashing after changing their absorbent materials. Washing the genital area with soap and water was more (123 females) prevalent among women (51%) than girls (49%) relative to the 110 females (more women- 54% than girls- 46%) who washed their genital area with water alone. Water for genital washing is primarily sourced from communal boreholes (54%) and hand-dug wells (44%). Contributions from other reported sources such as surface water (1%) and packaged (sachet) water, accounting for less than 1%, are minimal.

Additionally, Figure 5 shows the varied locations where participants changed their absorbent materials. All the 233 female participants reported changing their sanitary materials at home. Most (89 individuals, comprising 37% women, 63% girls) changed in the privacy of their toilets, followed by 74 (61% women, 31% girls) who preferred the bedroom, and 70 females (63% women, 37% girls) who chose the bath/washroom. However, only 125 of the females, more

women (51%) than girls (49%) changed their absorbent materials when away from home.

Overall, these findings underline diverse menstrual hygiene practices among females, highlighting differences in material usage, changing frequency, hygiene practices, and locations for changing menstrual materials, but further emphasizing the need to address these variations.

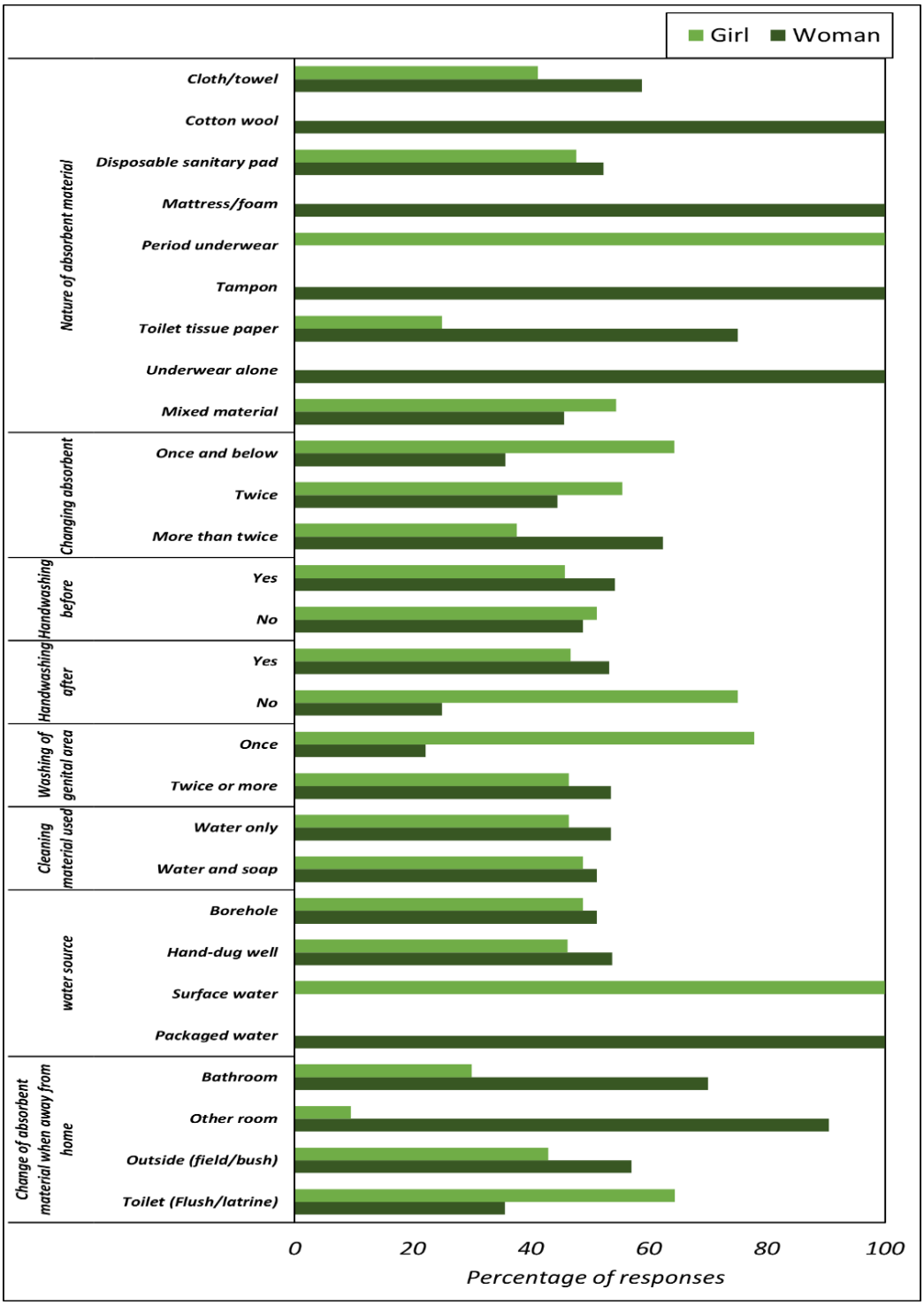


Figure 5. Menstrual hygiene management (MHM) among the study participants in Abeokuta City, Nigeria

Most common water-related diseases linked to unsafe water and WASH practices

Typically, water-related illnesses encompass various disease categories linked to contaminated water or poor WASH-related practices. The categories [6],[29] vary from water-borne (Ingestion of pathogens in contaminated water, e.g., typhoid) to water-washed (Poor hygiene/lack of access to safe water, e.g., diarrheal diseases), water-based (Infection by agents that spend part of their life cycle in water, e.g., schistosomiasis), and water-related vectors (Spread by vectors that breed or bite near water, e.g., malaria). To further understand health impact disparities, Figure 6 illustrated water-related diseases and its variation by gender in Abeokuta, Nigeria.

The primary insight from Figure 6 is that over 66% of the 33,522 diagnosed cases within a 15-month period at the selected PHCs in Abeokuta were associated with water-related ailments. Among the identified water-related diseases, malaria accounted for 68% of cases, followed by upper respiratory tract infections (14.4%), typhoid/enteric fever (7%), gastrointestinal tract infections (3.6%), and others - diarrheal diseases (3.2%), pelvic inflammatory disease/urinary tract infection (1.9%) and skin/dermal infection (1.8%). Interestingly, more women (32%) experienced water-related illnesses compared to children (29% girls and 26% boys) and men (13%). Although malaria might not directly relate to consuming unsafe water, it remains classified as a water-related disease due to its transmission through water-related vectors. Still, malaria and diarrheal diseases persist as significant causes of mortality worldwide [7].

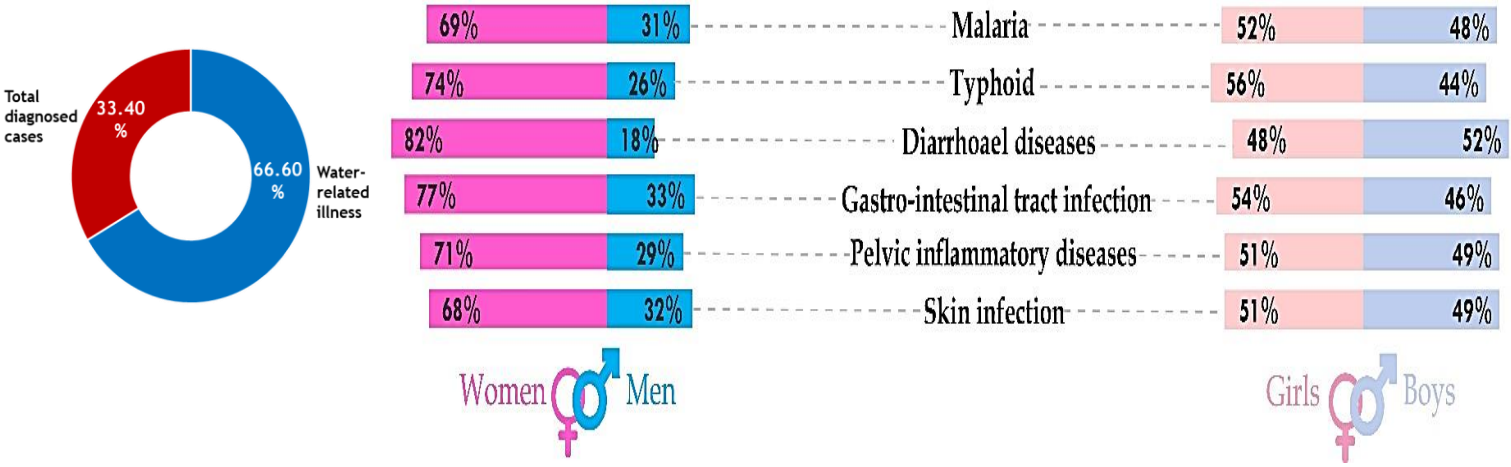


Figure 6. Gendered water-related illnesses in Abeokuta City, Nigeria

Potential gendered health risks exposure to hydro chemicals in water sources

For a more detailed analysis of health impact disparities, the investigation delved into Hazard Index (HI) calculations for different metals present in the water sources (Figure 7). When the HI value surpasses one, it signifies potential adverse health effects. In Abeokuta city, the HI values for calcium in water sources exceeded the safe limit (1.0), ranging from 784 to 2971 across all four sources in the order BH > SW > HDW > STW, with a higher risk observed in men compared to women and in boys compared to girls.

This implies an elevated risk of non-carcinogenic health problems linked to high calcium levels. Although calcium is crucial for the human body, needed to maintain bone and teeth structure, allow blood clotting and hormonal secretion, and the lack of it causes loss of bone mineral density in postmenopausal women, yet excessive concentrations can lead to health issues like diarrhoea and kidney failure [30]. Men and boys are more prone to high calcium exposure, leading to problems like kidney stones, due to factors such as increased testosterone levels, lower physical activity, and higher animal protein intake relative to women and girls [31]. The HI values for other hydro chemicals were below 1.0, indicating a low-risk level for non-carcinogenic health issues, albeit with variations in susceptibility based on gender and age.

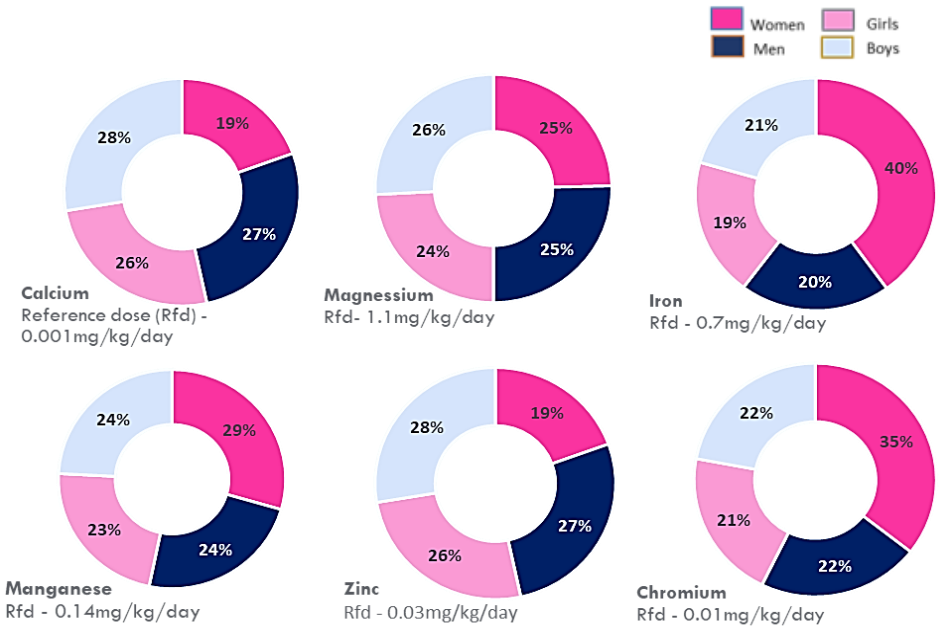


Figure 7. Differential health susceptibility (in % of Hazard index) to hydro-chemicals in Abeokuta-Nigeria

[6] Bartram, J., Baum, R., Coclanis, P. A., Gute, D. M., Kay, D., Mcfadyen, S., Pond, K., Robertson, W., Rouse, M. J., Bartram, J., & Hunter, P. (2023). Routledge Handbook of Water and Health Bradley Classification of disease transmission routes for water-related hazards. https://doi.org/10.4324/9781315693606.ch03

[7] WHS. (2022). World health statistics 2022 (Monitoring health of the SDGs). In Monitoring health of the SDGs. http://apps.who.int/bookorders

[25] WHO. (2017). Guidelines for Drinking-Water Quality Addendum. In Journal - American Water Works Association (Vol. 109, Issue 7). https://apps.who.int/iris/bitstream/handle/10665/254636/9789241550017-eng.pdf

[26] Chakraborty, R., Khan, K. M., Dibaba, D. T., Khan, M. A., Ahmed, A., & Islam, M. Z. (2019). Health implications of drinking water salinity in coastal areas of Bangladesh. International Journal of Environmental Research and Public Health, 16(19), 1–10. https://doi.org/10.3390/ijerph16193746

[27] Gizaw, Z., Addisu, A., & Dagne, H. (2019). Effects of water, sanitation and hygiene (WASH) education on childhood intestinal parasitic infections in rural Dembiya, northwest Ethiopia: An uncontrolled before-and-after intervention study. Environmental Health and Preventive Medicine, 24(1), 1–8. https://doi.org/10.1186/s12199-019-0774-z

[28] Liu, H., Zhang, X., Zhang, H., Yao, X., Zhou, M., Wang, J., He, Z., Zhang, H., Lou, L., Mao, W., Zheng, P., & Hu, B. (2018). Effect of air pollution on the total bacteria and pathogenic bacteria in different sizes of particulate matter. Environmental Pollution, 233, 483–493. https://doi.org/10.1016/j.envpol.2017.10.070

[29] Kulinkina, A. V., Mohan, V. R., Francis, M. R., Kattula, D., Sarkar, R., Plummer, J. D., Ward, H., Kang, G., Balraj, V., & Naumova, E. N. (2016). Seasonality of water quality and diarrheal disease counts in urban and rural settings in south India. Scientific Reports, 6(August 2015), 1–12. https://doi.org/10.1038/srep20521

[30] Tai, V., Leung, W., Grey, A., Reid, I. R., & Bolland, M. J. (2015a). Calcium intake and bone mineral density: Systematic review and meta-analysis. In BMJ (Online) (Vol. 351, pp. 1–14). https://doi.org/10.1136/bmj.h4183

[31] Kulinkina, A. V., Mohan, V. R., Francis, M. R., Kattula, D., Sarkar, R., Plummer, J. D., Ward, H., Kang, G., Balraj, V., & Naumova, E. N. (2016). Seasonality of water quality and diarrheal disease counts in urban and rural settings in south India. Scientific Reports, 6(August 2015), 1–12. https://doi.org/10.1038/srep20521

Addressing the Gendered Impacts on Health and Well-being

The impact of health and well-being on women, men, girls, and boys within the study area underscores the critical need to understand and address these issues through a gender-sensitive lens. Distinct disparities in water usage and health outcomes have significant implications for WASH management and necessitate tailored policies and interventions.

Water Sources and Health Impacts

Differences in water source preferences between genders was flagged, with more women and girls consuming STW, while more men and boys used BH and HDW. The observed hardness of water in HDW and BH, the primary water sources for men and boys, exhibits a strong correlation (Correlation coefficient = 0.97) with elevated calcium levels. This high calcium content might also contribute to the low pH in these sources, further affecting water quality. Also, calcium, among the hydro chemicals studied, presented the highest potential health risk (non-carcinogenic) across all water sources, with more vulnerability observed in men and boys than women and girls. In addition, all water sources investigated were found to contain microbial contamination, indicating disease-causing pathogens (enteric and opportunistic) at concentrations above 0 CFU $100mL^{-1}$ - implying that untreated water from these sources is not safe for drinking or domestic use but importantly emphasizing the need for point-of-use disinfection by e.g., chlorination utilizing household usable hypochlorite. Equally important is the necessity to implement suitable water safety strategies for frequently utilized water sources beyond public water systems [32].

Mineral content in hard water can disrupt the pH balance of human skin, weakening its protective barrier against harmful bacteria and skin conditions like irritation and eczema [27]. High concentrations of calcium in water have been linked with adverse health effects such as diarrhea and kidney failure [33], indicating a heightened susceptibility to compounded health impacts among men and boys in the study area due to water hardness and elevated calcium levels. Although reproductive issues and stillbirths in women due to water hardness and high calcium content are recognized, it is notable that men also face risks such as kidney stones and fertility complications. High calcium levels in water can disrupt the production of male reproductive hormones and reduce sperm count [34]. These health risks necessitate lowering calcium content in water sources to acceptable limits in the study area through feasible interventions like sodium form cation exchangers (or softeners) that could mitigate water hardness and minimize kidney stone production and the oxidative stress induced infertility for better kidney function and reproductive health, especially among men and boys.

Sanitation, Hygiene, and Health Burdens

The disparities in access to sanitation and hygiene facilities (summarized in Box 1) highlight critical concerns. For example, women who predominantly utilize and share sanitation facilities experience limited access to handwashing amenities compared to men and children (Figure 8). Children, particularly girls, seem to bear a heavier burden in water collection compared to adults. The responsibility for toilet cleaning is notably higher among women, followed to a lesser extent by girls, compared to men and boys. Despite having greater access to handwashing facilities, men and boys exhibit lower rates of handwashing after using the toilet. Additionally, water-related illnesses, more frequently reported by women, constitute the most common among diagnosed health cases at the PHCs in the study area, with malaria being prevalent at 68.1% and pelvic inflammatory disease/urinary tract infection (1.9%) and skin/dermal infection at 1.8%, the least. This pattern suggests that the impacts associated with water collection, such as fatigue, compromised time for other productive or social activities, and related health consequences, disproportionately affect girls. Apart from the elevated risks of abuse and sexual assault, women sharing sanitation facilities with men and boys face heightened vulnerabilities to complications during pregnancy and urinary infections [35]. Likewise, while boys and men face heightened risks of repercussions such as diarrheal diseases due to inadequate hygiene practices, women are more vulnerable to health impacts like throat irritation and nausea, caused by the inhalation of volatile organic compounds (VOCs) released from toilet cleaning disinfectants. These instances distinctly illustrate the varied effects of WASH services and practices on human health, exposing why the management of WASH should consistently adopt a gender-sensitive approach, ensuring that policies and action plans are tailored to address the specific needs of women, girls, men, and boys. Engaging them in the planning, decision-making processes, and governance of WASH services – this aligns well with the summation of UN-Water (2020). Specifically, anti-malaria initiatives to combat the most prevalent water-related illness in the study area is advised (Box 2).

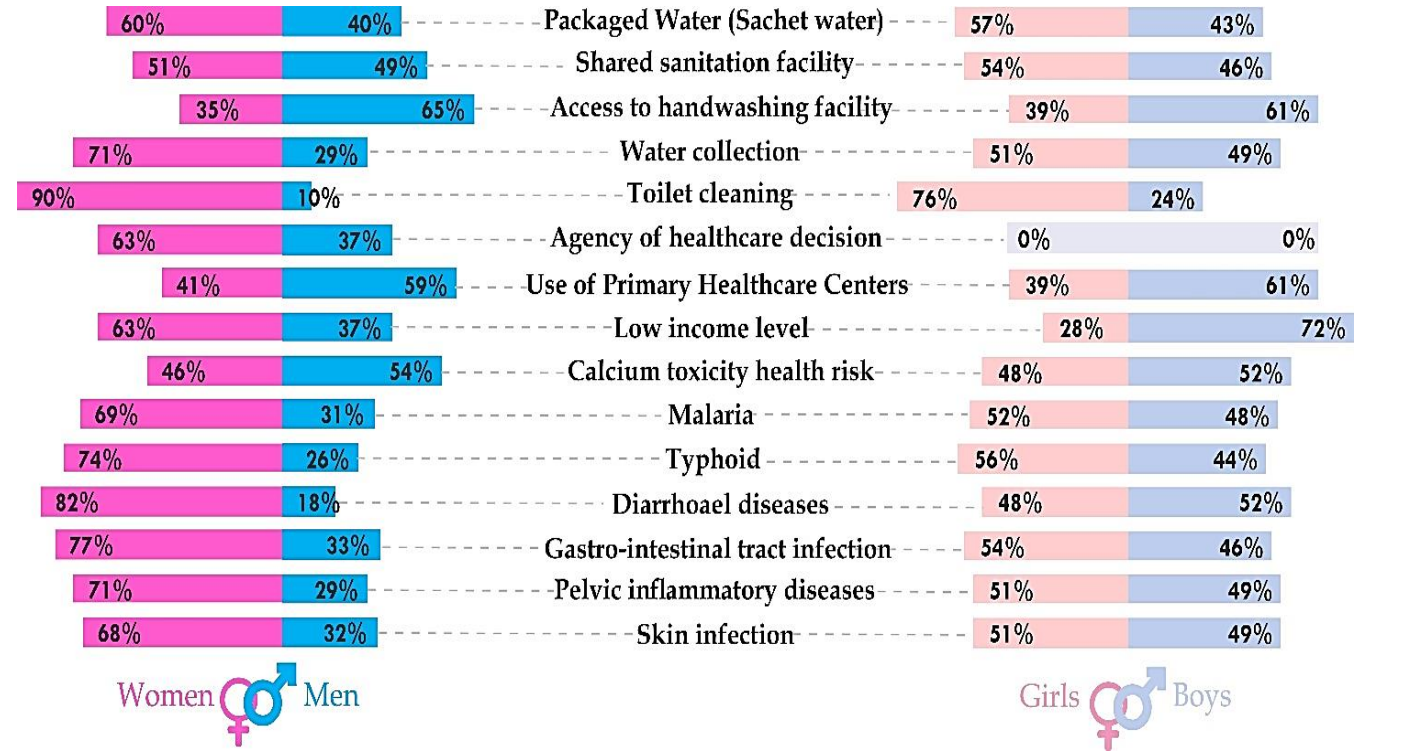


Figure 8. The overall outlook of gendered impacts of poor water quality in Abeokuta City, Nigeria

Box I: Disparities in access to water, sanitation, and hygiene facilities in Abeokuta City, Nigeria

Water sourcing:

- Children, especially girls, bear a greater responsibility for water collection relative to adults.

Sanitation and Hygiene:

- Women predominantly utilize and share sanitation facilities but lack access to handwashing facilities compared to men and children.
- The responsibility of toilet cleaning is primarily on women and, to a lesser extent, girls, than men and boys.
- Despite having greater access to handwashing facilities, men and boys are less likely to wash their hands after using the toilet.

Health Burdens:

- Water-related illnesses are more frequently reported by women, these diseases constitute the highest number of diagnosed health cases, with malaria being the most prevalent.
- Girls are disproportionately affected by the impacts associated with water collection, leading to fatigue, reduced time for education and social activities, and related health issues.
- Sharing sanitation facilities with men and boys poses risks for women, including pregnancy complications and genital/urinary infections, aside from increased vulnerability to abuse and sexual assault.

Box II: Anti-malaria initiatives.

Vector Control Programs:
Implementing indoor residual spraying (IRS) and distributing long-lasting insecticidal nets (LLINs) to prevent mosquito bites, the primary carriers of malaria.

Improved Diagnosis and Treatment:
Ensuring prompt and accurate diagnosis through the use of rapid diagnostic tests (RDTs) and providing effective treatment with appropriate (e.g., artemisinin-based) combination therapies (ACTs).

Public Awareness Campaigns:
Educating communities about preventive measures, symptoms, and the importance of seeking malaria treatment promptly.

Environmental Management:
Managing standing water and other breeding sites of mosquitoes to reduce their population and prevent the spread of malaria.

Disease Monitoring:
Monitoring, analysis, and reporting of gender-specific reported cases of malaria to facilitate understanding of gender disparities and ensure tailored interventions and evidence-based policymaking for health outcomes that are equitable, efficient, and impactful.

Research and Development:
Supporting research efforts to develop new drugs, vaccines, and innovative control strategies to combat drug-resistant malaria strains and prevent outbreaks.

Community Engagement:
Involving communities in malaria control strategies, encouraging participation, and empowering local health workers for better outreach and care.

International Collaboration:
Collaborating with global health organizations, governments, NGOs, and other stakeholders to share resources, knowledge, and best practices in malaria control and prevention.

Menstrual Hygiene Management and Health Risks

The preference for disposable sanitary pads by most women and girls, noted in this report, has positive health benefits. Some studies have shown that women who use disposable absorbent pads are less likely to develop urogenital infections than those using reusable pads [17]. Also, women in this study who adhere to more frequent changes and maintain better hygiene practices stand to be at lower risk of contracting RTIs than girls. Worrying, however, is the highlighted poor menstrual hygiene by girls, a persisting issue [36],[37] posing a considerable health risk in both the short term (such as Urinary Tract Infections (UTI), hepatitis B, and thrush) and the long term (including infertility and birth complications). Addressing this critical aspect requires promoting better MHM for girls through awareness campaigns, capacity-building initiatives, including deliberate investments in adequate WASH facilities, such as gender-specific toilets with affordable (either paid or unpaid) and accessible sanitary pad dispensers. These measures are pivotal in averting the negative health implications associated with inadequate menstrual hygiene practices

.



'WASH4Her' NGO distributing menstrual pad in Abeokuta city, Nigeria. *Photo: Instagram/Itunu Ogunkoya*

Disparities in Health Behaviors

Agency in healthcare decision-making and healthcare preference disparity are particularly highlighted in this study. Despite their lower wealth status, women predominantly hold the agency in making household healthcare decisions compared to men. While a significant majority (68%) resort to self-help healthcare practices, women tend to seek higher-level healthcare services such as private secondary health facilities and pharmacies, in contrast to men who more frequently utilize primary health facilities or resort to self-medication. Though these tendencies align with the socially prescribed roles for women, particularly in reproductive and healthcare aspects, the underlying implication is that enhancing women's economic status will lead to improved access to higher levels of healthcare services, elevating the overall well-being of households. Promoting these impacts of better women's economic status requires urgent advocacy for greater women's agency and rights through initiatives focused on women's economic empowerment. This involves ensuring equitable access to resources (such as water, land, technology, labor-enhancing tools/devices, and financial credit), allowing women the time, and opportunities to engage in productive activities while recognizing and compensating for their unpaid reproductive and domestic labor. These efforts (comprising empowering women's agency, enhancing women's access and control, and supporting women's productivity) are crucial for fostering a more equitable society and enhancing the overall welfare of households.

Addressing gendered impacts on health and well-being demands implementing these multifaceted solutions (Figure 9) that prioritize equitable access to WASH services, promote better MHM for girls, empower women economically, and ensure the active participation of all genders in decision-making processes. Such initiatives are essential for advancing improved health outcomes and transforming household well-being, particularly in the study area.

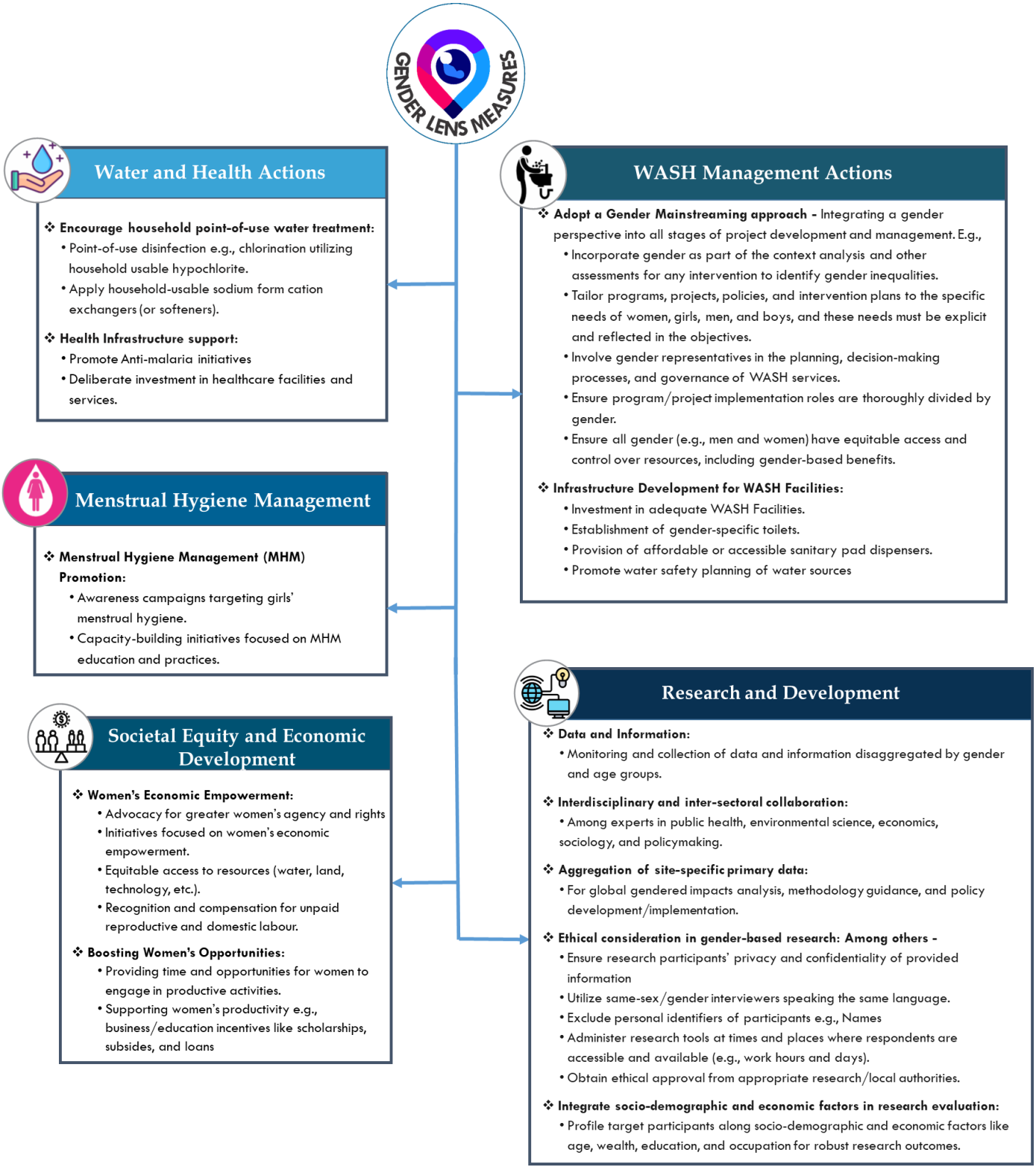


Figure 9. Addressing the Gendered Impacts of Water Quality and WASH

[17] Ademas, A., Adane, M., Sisay, T., Kloos, H., Eneyew, B., Keleb, A., Lingerew, M., Derso, A., & Alemu, K. (2020). Does menstrual hygiene management and water, sanitation, and hygiene predict reproductive tract infections among reproductive women in urban areas in Ethiopia? PLoS ONE, 15(8 August 2020), 1–15. https://doi.org/10.1371/journal.pone.0237696

[27] Gizaw, Z., Addisu, A., & Dagne, H. (2019). Effects of water, sanitation and hygiene (WASH) education on childhood intestinal parasitic infections in rural Dembiya, northwest Ethiopia: An uncontrolled before-and-after intervention study. Environmental Health and Preventive Medicine, 24(1), 1–8. https://doi.org/10.1186/s12199-019-0774-z

[32] Oluwasanya, G., & Carter, R. (2017): Water safety planning for small water supply systems: The framework and control measures, Journal of Water Science and Technology: Water Supply, Vol. 17 (6), 1524 – 1533. IWA Publishing, United Kingdom. https://doi.org/10.2166/ws.2017.057

[33] Tai, V., Leung, W., Grey, A., Reid, I. R., & Bolland, M. J. (2015b). Calcium intake and bone mineral density: Systematic review and meta-analysis. In BMJ (Online) (Vol. 351, pp. 1–14). https://doi.org/10.1136/bmj.h4183

[34] Sengupta, P. (2013). Potential health impacts of hard water. International Journal of Preventive Medicine, 4(8), 866–875. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3775162/

[35] UN Water. (2020). Delivering the promise: Safe water and sanitation for all by 2030 Solving the water and sanitation crisis Purpose and. In www.unwater.org

[36] WASH united. (2022). Menstrual Health and Hygiene. The World Bank. https://www.worldbank.org/en/topic/water/brief/menstrual-health-and-hygiene

[37] Winkler, M. S., Jackson, D., Sutherland, D., Lim, J. M. U., Srikantaiah, V., Fuhrimann, S., Medlicott, K., Aboah, M., Miyittah, M. K., Ademas, A., Adane, M., Sisay, T., Kloos, H., Eneyew, B., Keleb, A., Lingerew, M., Derso, A., Alemu, K., … Orebiyi, E. (2021). Spatial distribution and contamination of heavy metals in surface water, groundwater and topsoil surrounding Moghan's tannery site in Ardabil, Iran. International Journal of Environmental Analytical Chemistry, 11(1), 1–13. https://doi.org/10.1002/9781119097136.part5



A woman sourcing for drinking water. *Photo: UN Women/Ryan Brown*

Conclusions



A self-supply hand-dug well in Abeokuta city, Nigeria. *Photo: Cranfield University Ph.D. Thesis/Grace OLUWASANYA*

The urgency of planning and implementing robust water safety protocols for non-utility self-supply systems

The significance of self-supply water sources, like hand-dug wells and boreholes, in areas underserved by public utilities was highlighted by Oluwasanya et al., (2011) [38] as they become the primary go-to water sources for users, a point reiterated in this report. Previous findings by Oluwasanya (2013) and Oluwasanya and Carter (2013, 2017) emphasized the necessity for robust water safety protocol for these small systems. Stressing that safeguarding these water sources is the primary defense against microbial and chemical contamination and implementing water safety interventions for these systems is crucial to ensure safe household water for a broader population, contributing to poverty alleviation, supporting livelihood activities, and advancing SDGs 3 and 6.

These self-supply water sources are mostly privately owned and unregulated, necessitating user-centered oversight and dedicated institutions for planning, implementation, and enforcing water safety protocols. Effective implementation and compliance with water safety measures, however, requires suitable support programs such as training, awareness campaigns, and capacity-building initiatives. Also, providing incentives like subsidies (via micro-financing for source improvement) and accessible water laboratories can aid water asset owners [39].

This study revealed contamination of all tested water sources in the area with disease-causing pathogens, including enteric and opportunistic microbes, harmful to human health. Elevated levels of chemicals like calcium, associated with severe medical conditions like sepsis, diarrhea, kidney failure, and fertility complications, were also identified.

Given the state of water quality issues outlined in this report, the urgency of planning and implementing robust water safety protocols for predominantly utilized water sources, beyond public water systems, cannot be overstated - ensuring the protection of lives relies heavily on this action.

Mainstreaming gender concerns and needs: A "6th sense" accelerator for SDG 6

The pilot assessment reveals staggering statistics that points to significant challenges about water access and sanitation, undermining the aspirations outlined in SDG 6. For instance, STW, commonly sold as treated and perceived as a safe drinking water source, is frequently used due to the absence of a public water supply. Communal boreholes and HDW serve as the primary sources for cooking and domestic activities (like bathing, laundry, and sanitation), respectively. A significant majority (82% out of 456 participants) utilize less than 50 L of water per day, falling below the recommended threshold of 50 – 100 L/person/day [40]. 86% (for drinking) and 91% (for domestic uses) implement no form of water treatment. Approximately 98% of individuals rely on improved sanitation facilities (such as flush toilets and lavatories); however, these facilities are at an unsafe distance of < 30 m from a water source. Additionally, a large majority (74%) lack access to a handwashing facility.

The absence of public water sources, forcing most individuals in the study area to rely on household water alternatives, presents a worrying indication - failure to meet the universal access target set in SDG 6.1 *("…achieving universal access to safe and affordable drinking water…by 2030"*). Also, the prevalent use of shared sanitation facilities, at unsafe distances from water sources and the lack of access to handwashing facilities with soap and water, deviates from the objectives highlighted in SDG 6.2 (*"…achieve access to adequate and equitable sanitation and hygiene for all…by 2030*"). These findings - the absence of public water sources, reliance on alternative household water sources, and inadequate access to sanitation and hygiene facilities - emphasize that current WASH services in the study area is grossly inadequate. But importantly raise another major concern; questioning the feasibility of attaining SDG 6 - the aim to ensure universal access to safe drinking water and equitable sanitation and hygiene for all, by 2030.

Additionally, this study reveals gender-based disparities across all highlighted water-related issues, suggesting that the impacts of water-related actions/events (poor water quality, WASH and health-related culture and practices) are not gender-neutral nor evenly distributed between women and men, and boys and girls. The study also outlined the need and how to address the gendered differences for better WASH management and health outcomes - signalling that addressing gender-based disparities in WASH and health interventions is crucial to fast-tracking safe water and sanitation (SDG 6) for all or that, essentially, SDG 5 holds a significant role in achieving SDG 6.

UN-Water (2020) proposed five global accelerators – optimized financing, improved data and information, capacity development, innovation, and governance – to fast-track SDG 6. Improved data and information, clearly, must integrate sex-disaggregated data to uncover the often-masked gender gaps in water management – this aligns with UNESCO WWAP's emphasis on collecting such data to assess and address gendered water-related issues and advance gender equality i.e., SDG 5 [41][42][43]. However, the most critical of the pathways is Governance, essentially, facilitating effective application of other accelerators to enhance basic human services and attain sustainable development for inclusive household water security. Governance for effective water management, however, necessitates cross-sectoral collaboration, clear role delineation, stakeholder engagement, inclusive institutions but also mainstreaming gender considerations (the missing "6th" sense). Integrating gender concerns and needs entails increasing women's representation in decision-making and leadership roles within the water sector to accelerate progress toward SDG 5 and comprehensive water management.

Gendered Impacts, the overall outlook

This study indicates a profound inadequacy in accessing WASH services within the pilot study area, raising considerable doubts about achieving SDG 6 by 2030. Without point-of-use treatment, the water sources are unsuitable for potable uses, potentially posing compounded health risks associated with hardness and high calcium content, particularly affecting boys. Girls are likely the most affected by the repercussions of water collection, including time constraints, health implications, and safety concerns. Men and boys face a higher risk related to poor hygiene, while women may be more susceptible to health effects stemming from toilet cleaning responsibilities and shared sanitation facilities. Despite the preference for disposable sanitary pads among most women and girls, women change more frequently and adopt better menstrual hygiene practices compared to girls. The persistence of poor menstrual hygiene among girls may pose substantial health risks in the near and distant future. Enhancing women's economic status could lead to improved access to superior healthcare services and significantly elevate household well-being. Overall, the study underscores the gendered impacts of unsafe water, inadequate WASH services, and practices on human health and overall well-being, emphasizing that gendered statistics through sex-disaggregated data is crucial to uncover the often-masked

differential impacts, which are not gender-neutral or evenly distributed across age groups (Figure 8).

The primary methodological assumption that may be improved is the study's sole focus on 1) assessing water quality and profiling water users residing in communities situated within a 1 km radius of the selected PHCs, 2) excluding the secondary and tertiary health facilities because of data access bureaucracy. This approach does not offer a comprehensive city-wide analysis of the diverse impacts of inadequate water quality. Similarly, the study employed random sampling and sample size estimation, acknowledging their inherent imperfections in accessing a broader population and potential biases, they are presumed to be representative of the entire city and possibly generalizable at the national level, given the study area typifies most Nigerian cities. Leaving no one behind in access to good water quality is a fundamental human right that demands a rights-based approach. However, this study revealed clear gendered impacts of poor water quality and WASH practices, representing unaddressed challenges that may impede achieving SDG 6 by 2030.

Notably, the absence of gender-specific statistics, standardized global methodologies for collecting sex-disaggregated data, limited political commitment, and constrained financial resources to extend this assessment on a broader or global scale pose substantial limitations. The timing of data collection also failed to capture individuals at work or schooling, which may have influenced the study's representativeness. These limitations, however, do not change the primary outcome nor the aim to present a guidance through this assessment methodology, which was successfully piloted to promote evidence-based gendered impacts of WASH-related services, practices, and events. So, this report is an introductory guide. The methodology developed and piloted is scalable and can be further refined to explore and track site-specific differential health and socioeconomic effects of poor water quality, especially in areas with similar attributes to the study area.



Women and children sourcing for water. *Photo: Flickr/Axel Fassio/CIFOR-ICRAF, CC BY-NC-ND 2.0*

[38] Oluwasanya, G., Smith, J., & Carter, R. (2011). Self-supply systems: Urban dug wells in Abeokuta, Nigeria. Water Science and Technology: Water Supply, 11(2), 172–178. https://doi.org/10.2166/ws.2011.026

[39] Oluwasanya, G. (2013). Qualitative risk assessment of self-supply hand-dug wells in Abeokuta, Nigeria: a water safety plan approach. Waterlines 32(1): 36–49. Practical Action Publishing, United Kingdom. http://dx.doi.org/10.3362/1756-3488.2013.004

[40] Miletto, M., Pangare, V. and Thuy, L. (2019). Tool 1 – Gender-responsive indicators for water assessment, monitoring, and reporting. In ZEDlife (pp. 34–42). https://doi.org/10.4324/9780429345715-5

[41] Pangare, V., Miletto, M., & Thuy, L. (2019). Tool 4: Questionnaire for the collection of sex-disaggregated water data. http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/water-and-gender/methodology-indicators-and-toolkit/

[42] UNESCO WWAP. (2021). Taking Stock of Progress Towards Gender Equality in the Water Domain Where do we stand 25 years after the Beijing Declaration? http://www.unesco.org/open-access/



Close-up view of person washing hand. *Photo: Freepix*

Appendix I-Methods and Input Data

This section describes the input data and methods used in assessing the gendered impacts of water quality and WASH in Abeokuta City, Nigeria. Abeokuta exhibits myriad attributes shared by most cities in Nigeria. These include limited access to groundwater resources owing to the underlying crystalline basement complex, inadequate municipal water provisions due to factors like insufficient funding, and underutilization and an uneven distribution of healthcare facilities throughout the city (G. Oluwasanya et al., 2023).

A mixed-method approach was applied for the case study to collect real-time local-specific field data and information from primary and secondary data sources, open-access media, and online and print documents. The field survey (September-December 2022) in Abeokuta documented 15 months (August 2021-October 2022) of medical records from 10 PHCs - Primary Healthcare Centres. These PHCs were selected by cluster sampling to ensure a fairly uniform geographical spread across the Abeokuta metropolis. Information such as patient's age, gender category, and diagnosed water-related infections was collated, including the most presenting complaints/symptoms, diagnosis outcome (i.e., treated/not treated, referral or dead), and doctor-to-patient ratio for each PHC. Differential water-related health cases were targeted to identify prevailing water-related health issues.

The quality of the water resources being used by the most immediate (within a 1 km range) communities of selected primary healthcare facilities was also assessed. Thirty-five composite water samples from the four major water sources (hand-dug wells - HDW, boreholes - BH, (perennial) surface water – SW, and packaged drinking water (Sachet) – STW) were collected. Forty sampling points stratified based on the 10 PHCs (4 points around a PHC location) were targeted but SW sampling was limited to 5 points due to availability and accessibility. The water samples were collected in 250 ml amber bottles and 25 ml sterilized bottles during the wet season (September – October 2022) and transported in iced coolers to HEGADA Scientific Laboratory for hydro chemical and biological analysis, respectively. Twenty-eight parameters were tested - 4 physicochemical (in-situ) using the HANNA HI98129 Combo meter, hydro chemicals (16), and DNA-specific pathogens (8). Analysis of the hydro chemicals followed standard methods (APHA, 1981). The DNA-specific pathogens were detected through nuclei acid extraction, amplification using qPCR assays, and sequencing to assess the prevalence of water-borne zoonotic pathogens (Khan et al., 2022; Liu et al., 2018).

Other field activities included geo-referencing selected PHCs and water sampling points, and an online quantitative public survey via Microsoft Forms. The survey via a structured interviewer-administered questionnaire, validated by a pilot test, employed a stratified sampling technique along gender lines and age groups (man, woman, boy, and girl). The sample size, an estimated minimum of 400 participants, was determined by Equation 1 (Yamane, 1964):

$n = \frac{N}{1+Ne^{\wedge}2}$ …… Equation 1

where n is the survey sample size; N is the population size; and e is the acceptable 5% sampling error.

The survey documented responses from 456 participants on a set of questions that included six major components (Water source, Sanitation, Hygiene practices, MHM, Socio-demographic/economic factors, and Health culture practices) of water and gender interlinkages. The purpose is to understand better how these components influence the impact of water quality and WASH on gender (Table 1). The major WASH-related questions were adapted from (WHO/UNICEF JMP, 2006) and MHM questions stemmed from the Menstrual Practices Questionnaire (Hennegan et al., 2020). Inclusion criteria were 'water users residing within a 1 km range of the selected PHCs beyond the 24 months preceding the study and were at least 12 years as of the last birthday'. Water users with less than 24 months of residency and less than 12 years were excluded. Twelve years is the average age for onset of menarche in female adolescents (Marques *et al.*, 2022). Informed consent was obtained after explaining the purpose of the study. Verbal consent was secured from the parents/guardians of participants (male and female) between 12 - 18 years and minorities (e.g., those differently abled). Participants' privacy and the confidentiality of the information they gave were ensured at all levels; personal identifiers were not collected, the questionnaire was administered individually at times and places where respondents were accessible and available (work hours and days), and the use of same-sex interviewers speaking the same language was employed. These helped to achieve a high response rate, maximum time utility, and minimal refusals of the respondents. The study involved no medical procedures, presented no harm to the participants, and followed the World Health Organization (WHO) guidance on research methods for Health Emergency and Disaster Risk Management – HEDRM (WHO, 2019; Lo *et al.*, 2020), and the ethical protocol approved by the Ogun State Hospital Management Board.

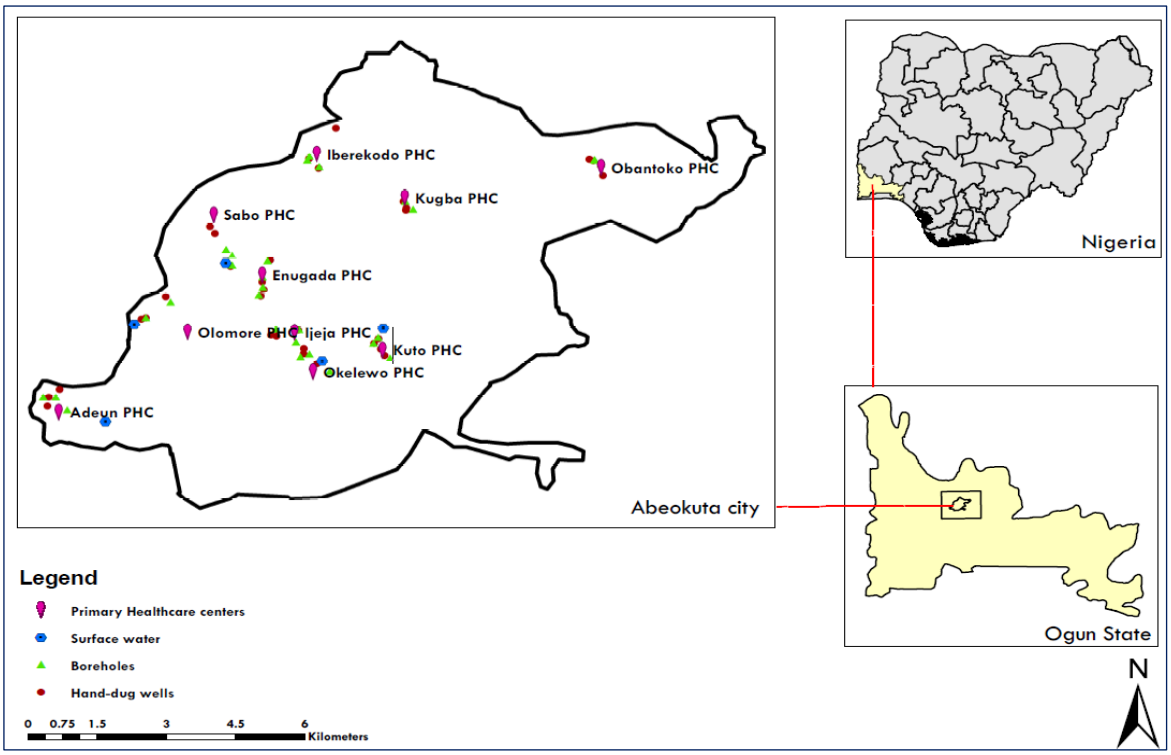


Figure 1-1. Map of Abeokuta city, Ogun State, Nigeria showing selected Primary Healthcare Centres



Figure 1-2. Water quality and Gender - Major components of the qualitative assessment

The study area map was generated with ArcMap 10.5 software. Descriptive statistics (the means and standard deviations) of the water quality data were computed according to water source type, including a comparative assessment of obtained concentrations with the WHO standard values for drinking water (WHO, 2017). Pearson Chi-square test for independence (categorical variables) was used to examine differences across gender groups for the survey and medical data. Degrees of freedom were defined as $(r - 1) \times (c - 1)$, where r = the number of rows and c = the number of columns, and the Significance level was set at $P < 0.05$. All these data were analyzed using SPSS (software version 27). Hydro chemical parameters like pH, electrical conductivity, calcium, magnesium, nitrate, and chloride for groundwater sources were selected separately to generate spatial distribution maps using point data analysis in a GIS environment. The point feature was prepared using the location data showing the position of water sample locations helped by GPS technology to enhance spatial accuracy. The data obtained from chemical analysis for each water sample were stored in an Excel format and added to each point spatially drawn in ArcMap 10.5 for the entire study area. These spatial and non-spatial databases were jointly applied for the generation of spatial distribution maps using Inverse Distance weighted interpolation techniques to analyse variations of hydro chemical parameters (Karunanidhi et al., 2021).

The health risk of six (Ca, Mg, Fe, Mn, Zn and Cr) hydro chemicals with potential toxic health effects was estimated. Chronic daily intakes (CDI) of toxic metals from drinking water sources were calculated (Equation 2) using methods adopted by (Kavcar *et al.*, 2009):

$$CDI = \frac{C \times IR}{BW} \quad \text{..... Equation 2}$$

Where CDI is the chronic daily intake in mg/kg/day; C is the concentration of the hydro chemical contaminant in water samples, IR is the ingestion rate per unit time (2 L/day for women and men, and 1 L/day for girls and boys), and BW is the average body weight (women - 89.8 kg, men - 77.3 kg, girls - 40.7 kg and 38.2 kg for boys (Adekoya et al., 2020; Senbanjo & Oshikoya, 2012). The hazard index (HI) (USEPA, 2017) was calculated (Equation 3) as:

$$HI = \frac{CDI}{Rfd} \quad \text{..... Equation 3}$$

Where HI is the non-carcinogenic hazard index, Rfd (the chronic oral reference dose) is an estimate of a daily oral

exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (Bamuwamye *et al.*, 2015). HI value exceeding one implies a daily oral level of the hydro chemical exceeded the Rf_d value - indicating a health exposure. HI value ≤ 1 indicates no negative health issue.

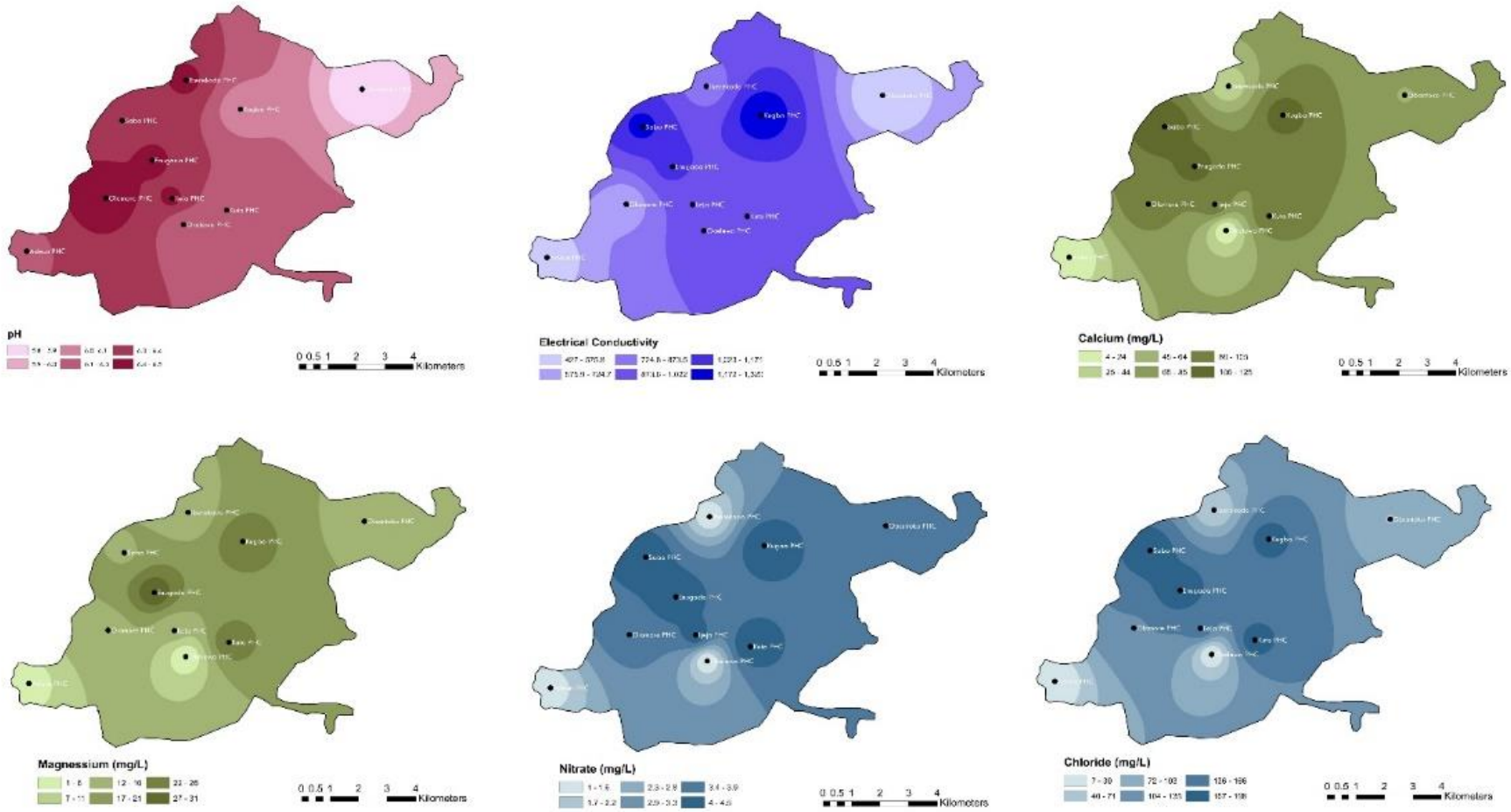
Last, gender analysis was performed using the Hazard Analytical Framework: Activity profile (who does what?); Access and control profile (who has what?); Analysis of factors and trends (socioeconomic context) and the programme cycle (what gender considerations are needed?).

The overall assessment framework (Appendix III) is a 5-step approach describing the process of assessing differential impacts of poor water quality from method design to the field activities, which include water sampling and laboratory analysis, public survey, and health data collection, to the data and gender analysis. Using this framework with the detailed information on the study method and analytical components also in (G. Oluwasanya et al., 2023), it should be possible for professionals in water, climate, gender, health and related disciplines and sectors to assess site-specific gendered impacts of unsafe water.

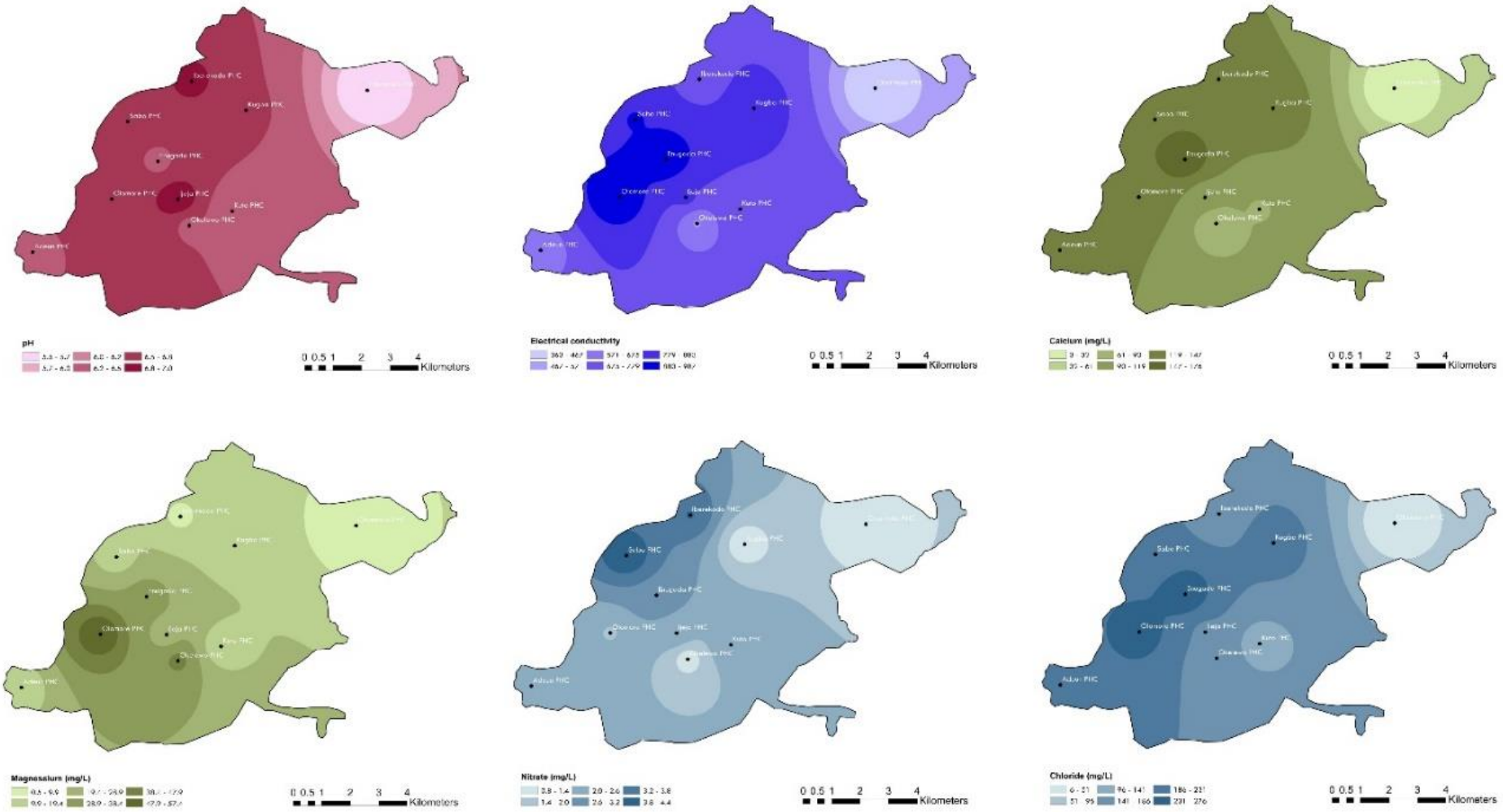


Improvised handwashing system.
Photo: Shutterstock/Ivan Bruno de M

Figure 1-3. Spatial distribution of hydro-chemicals in hand-dug wells and borehole sources, Abeokuta city, Nigeria



a. Hand-dug wells


pH
Electrical conductivity
Calcium (mg/L)
Magnesium (mg/L)
Nitrate (mg/L)
Chloride (mg/L)
0 0.5 1 2 3 4
Kilometers

b. Boreholes

Table 1-1. Water quality status (September – October 2022) in Abeokuta City, Nigeria

Water quality parameter	Hand-dug well (HDW)		Borehole (BH)		Sachet Water (STW)		Surface Water (SW)		WHO Standard (WHO, 2017)
	Mean ± S.D	Range	Mean ± S.D	Range	Mean ± S.D	Range	Mean ± S.D	Range	
pH	6.3 ± 0.2	0.8	6.5 ± 0.4	1.6	6.3 ± 0.3	1.0	6.9 ± 0.2	0.6	6.5-8.5
EC (µS/cm)	860 ± 307	893	732 ± 194	625	82 ± 42	120	467 ± 68	173	1000
Temperature (°C)	28.70 ± 1.12	3.80	28.40 ± 0.85	3.10	29.10 ± 1.23	3.20	27.70 ± 1.16	2.90	-
TDS (mg/L)	430 ± 154	447	375 ± 96	313	41 ± 20	58	235 ± 34	85	500
Turbidity (NTU)	1.8 ± 1.2	3.3	1.6 ± 1.0	2.8	1.4 ± 0.7	1.9	5.8 ± 4.1	10.4	5
Hardness (mg $CaCO_3$/L)	251 ± 149	397	373 ± 163	583	114 ± 150	376	283 ± 64	150	200
Alkalinity (mg/L)	47.4 ± 11.6	38.0	53.4 ± 12.6	38.0	36.4 ± 21.7	58.0	38.8 ± 10.6	28.0	120
Chloride (mg/L)	118 ± 77	191	176 ± 77	270	51 ± 68	174	123 ± 39	94	250
Nitrate-NO_3 (mg/L)	3.3 ± 1.5	3.5	2.4 ± 1.2	3.7	2.1 ± 1.3	3.9	2.1 ± 1.1	2.4	50
Sulphate (mg/L)	148 ± 97	302	158 ± 100	364	100 ± 72	212	190 ± 263	621	500
Phosphate (mg/L)	2.77 ± 2.71	7.00	0.66 ± 0.56	1.90	0.57 ± 0.42	1.20	0.76 ± 0.28	0.60	-
Calcium (mg/L)	75 ± 47	122	113 ± 50	173	35 ± 46	122	93 ± 22	51	75
Magnesium (mg/L)	15.3 ± 9.5	30.2	22.1 ± 17.2	57.0	6.3 ± 8.9	26.2	12.7 ± 2.3	5.8	50
Iron (mg/L)	0.03 ± 0.02	0.05	0.03 ± 0.02	0.05	0.02 ± 0.02	0.05	0.01 ± 0.01	0.03	0.3
Manganese (mg/L)	0.09 ± 0.10	0.29	0.19 ± 0.08	0.25	0.17 ± 0.28	0.28	0.10 ± 0.09	0.22	0.4
Zinc (mg/L)	0.04 ± 0.02	0.04	0.02 ± 0.02	0.05	0.01 ± 0.00	0.02	0.03 ± 0.01	0.03	3
Chromium (mg/L)	0.02 ± 0.02	0.04	0.02 ± 0.01	0.04	0.02 ± 0.01	0.03	0.01 ± 0.01	0.03	0.05
Cadmium (mg/L)	0.00 ± 0.00	0.00	0.00 ± 0.00	0.01	0.00 ± 0.00	0.01	0.00 ± 0.00	0.01	0.003
Lead (mg/L)	0.03 ± 0.02	0.08	0.04 ± 0.02	0.02	0.05 ± 0.03	0.08	0.02 ± 0.03	0.06	0.01
Arsenic (mg/L)	0.14 ± 0.09	0.24	0.12 ± 0.09	0.22	0.13 ± 0.06	0.22	0.12 ± 0.06	0.17	0.01
Total coliform (CFU 100 mL^{-1})	0.019 ± 0.034	0.094	0.024 ± 0.038	0.116	0.050 ± 0.054	0.128	0.021 ± 0.030	0.084	0
E. coli (CFU 100 mL^{-1})	0.008 ± 0.027	0.084	0.008 ± 0.013	0.034	0.002 ± 0.004	0.008	0.006 ± 0.017	0.054	0
E. coli 0157:H7 (CFU 100 mL^{-1})	0	0	0	0	0	0	0	0	0
Clostridium perfringens (CFU 100 mL^{-1})	0	0	0	0	0	0	0	0	0
Actinobacter spp. (CFU 100 mL^{-1})	0.001 ± 0.003	0.010	0.002± 0.008	0.024	0.002 ± 0.005	0.012	0.001 ± 0.004	0.012	0
Acinetobacter baumannii (CFU 100 mL^{-1})	0	0	0.003 ± 0.008	0.026	0.010 ± 0.018	0.042	0	0	0
Vibrio cholerae (CFU 100 mL^{-1})	0.0004 ± 0.001	0.004	0.0016 ± 0.005	0.016	0.0056 ± 0.008	0.018	0	0	0
Shigella dysenteriae/salmonella typhi (CFU 100 mL^{-1})	0.003 ± 0.009	0.028	0.035 ± 0.062	0.196	0.045 ± 0.053	0.124	0.008 ± 0.026	0.082	0

NB: '-'The water quality parameter is not of health concern, no threshold value available; coloured cells were above WHO threshold.

Table 1-2. Water, Sanitation, and Hygiene-related characteristics/practices among the study participants in Abeokuta City, Nigeria

A: Water-related characteristics		B: Sanitation and hygiene-related characteristics		C: Gendered Water, Sanitation, and Hygiene (WASH) Practices	
Variables	Frequency n(%)	Variables	Frequency n(%)	Variables	Frequency n(%)
Main Water source (drinking), n = 456		**Type of sanitation facility (n = 456)**		**Water collection (n = 455)**	
In-house connection (Borehole/Hand-dug well)	17(3.7)	Flush toilet	333(73.0)	Women (W)	95(21.0)
Borehole (Communal)	122(26.8)	Pit latrine	117(25.7)	Men (M)	38(8.0)
Hand-dug well	33(7.2)	Open defecation	6(1.3)	Girls (G)	108(23.7)
Packaged (Sachet) water	269(59.0)	**Distance of sanitation facility to a water source (n = 456)**		Boys (B)	104(23.0)
Surface water	2(0.4)	< 5m	44(9.7)	Anyone available	93(20.5)
Rainwater	13(2.9)	6 - 30m	240(52.6)	Outsourced	3(0.7)
Main Water source (Cooking), n = 456		> 30m	172(37.7)	In-house connection	3(0.7)
In-house connection (Borehole/Hand-dug well)	47(10.3)	**Distance of water source to other threats (burial sites, solid waste dumps)**		Others (children/female adults, and children)	11(2.4)
Borehole (Communal)	252(55.3)	< 5m	41(9)	**Toilet cleaning (n = 456)**	
Hand-dug well	149(32.7)	6 - 30m	137(30)	Women	214(46.9)
Packaged (Sachet) water	2(0.4)	> 30m	278(61)	Men	24(5.3)
Surface water	6(1.3)	**Sharing of sanitation facility**		Girls	67(14.7)
Water source (domestic non-drinking/cooking), n = 422		1 - 3 people	135(29.6)	Boys	21(4.6)
Borehole (Communal)	122(29.0)	4 - 10 people	232(50.9)	Anyone available	66(14.5)
Hand-dug well	252(59.7)	> 10 people	78(17.1)	Outsourced	10(2.2)
Packaged (Sachet) water	9(2.1)	None	11(2.4)	Mixed responses (W+G+B; W+M; W+G)	54(11.8)
Surface water	1(0.2)	**Cleaning of sanitation facility**		**Handwashing with soap after use of toilet (n = 456)**	
Rainwater	28(6.6)	With water	1(0.2)	Yes	414(91)
Others (In-house/reservoirs/mixed*)	10(2.4)	With soap and water	129(28.7)	No	42(9)
Water use per capita per day (n = 380)		With water and disinfectant	183(40.8)	**Handwashing with soap after toileting (Yes, n = 414)**	
< 20L	186(49.0)	All the above	136(30.3)	Women	122(29.5)
21 - 50L	127(33.4)	**Frequency of toilet cleaning (n = 456)**		Men	96(23.2)
> 50L	67(17.6)	On-demand	8(1.8)	Girls	99(23.9)
Water treatment (drinking), n = 456		Once a day	118(25.9)	Boys	97(23.4)

Yes	62(14)	At least once a week	248(54.4)	**Handwashing with soap after toileting (No, n = 42)**	
No	394(86)	> Twice a week	82(17.9)	Women	7(16.7)
Water treatment (domestic) n = 456		**Handwashing facility (n = 456)**		Men	16(38.1)
Yes	39(9)	Yes (with soap and water)	97(21.3)	Girls	8(19.0)
No	417(91)	Yes (without soap and water)	22(4.8)	Boys	11(26.2)
Water treatment methods (Drinking) n = -62		No	337(73.9)		
Filtration	4 (6.5)	**Frequency of handwashing per day (n = 119)**			
Boiling	36(58.0)	On-demand	82(68.9)		
Use of alum	6(9.7)	Once daily	17(14.3)		
Sedimentation (settling without the use of chemicals)	7(11.3)	At least twice daily	18(15.1)		
Disinfection (Use of household usable hypochlorite)	8(12.9)	Seldom	2(1.7)		
Mixed method (Boiling and filtration)	1(1.6)				
Water treatment methods (Domestic) n = 39					
Filtration	1(2.6)				
Boiling	13(33.3)				
Use of alum	9(23.1)				
Sedimentation (settling without the use of chemicals)	1(2.6)				
Disinfection (Use of household usable hypochlorite)	13(33.3)				
Others (Pray and Annual treatment by experts)	2(5.1)				

Table 1-3. Gendered Health culture/practices among the study participants in Abeokuta City, Nigeria

Variables	Frequency	Variables	Frequency				
	n(%)		Total n(%)	Woman n(%)	Man n(%)	Girl n(%)	Boy n(%)
Healthcare decisions (Agency), n = 454		**Healthcare facilities/approaches (n = 454)**					
Woman (W)	272(59.9)	Tertiary healthcare facilities	22(5.0)	7(32)	7(32)	3(13)	5(23)
Man (M)	161(35.5)	Secondary healthcare facilities (Private)	105(23.1)	32(30.5)	24(22.9)	14(13.3)	35(33.3)
Boy (B)	3(0.7)	Secondary healthcare facilities (Public)	25(5.5)	7(28)	8(32)	3(12)	7(28)
Either M or W	16(3.5)	Primary Healthcare Centers (PHC)	68(15.0)	15(22.1)	22(32.4)	12(17.6)	19(27.9)
Both M and W	2(0.4)	Pharmacy (P)	84(18.5)	20(24.0)	16(19.0)	33(39.2)	15(17.8)
Healthcare sponsorship/funding (n = 456)		Homecare	66(14.5)	23(35.0)	9(13.6)	26(39.4)	8(12.0)
Self-sponsored	309(67.8)	Traditional (T)	32(7.0)	10(31.0)	12(37.5)	6(19.0)	4(12.5)
Third-party (Parents/Govt. or Private insurance)	147(32.2)	Self-medication	35(7.7)	6(17.1)	12(34.3)	7(20.0)	10(28.6)
		Mixed approaches (P+PHC; T+P; Self-Medication +Homecare +P)	12(2.6)	8(67)	1(8)	3(25)	0(0)
		None	2(0.4)	0(0)	0(0)	0(0)	2(100)
		Others (Faith, Sleep therapy)	3(0.7)	1(33.3)	1(33.3)	0(0)	1(33.3)

Table 1-4. Menstrual hygiene management (MHM) among the study participants in Abeokuta City, Nigeria

Variables	Frequency		
	Total n(%)	Woman n(%)	Girl n(%)
Nature of absorbent material for menstruation (n = 233)			
Cloth/towel	17(7.3)	10(58.8)	7(41.2)
Cotton wool (CW)	1(0.4)	1(100)	0(0)
Disposable sanitary pad (DSP)	149(64.0)	78(52.3)	71(47.7)
Mattress/foam	2(0.9)	2(100)	0(0)
Period underwear	1(0.4)	0(0)	1(100)
Tampon	1(0.4)	1(100)	0(0)
Toilet tissue paper	4(1.7)	3(75)	1(25)
Underwear alone	1(0.4)	1(100)	0(0)
Mixed material (Cloth + DSP; CW + DSP; DSP + Underwear)	57(24.5)	26(45.6)	31(54.4)
Frequency of changing absorbent material during menstruation (n = 233)			
Once and below	14(6.0)	5(35.7)	9(64.3)
Twice	110(47.2)	49(44.5)	61(55.5)
More than twice	109(46.8)	68(62.4)	41(37.6)
Handwashing before the change of blood-absorbent material (n = 233)			
Yes	151(64.8)	82(54.3)	69(45.7)
No	82(35.2)	40(48.8)	42(51.2)
Handwashing after the change of blood-absorbent material (n = 233)			
Yes	225(96.6)	120(53.3)	105(46.7)
No	8(3.4)	2(25)	6(75)
Frequency of washing the genital area per day during menstruation (n = 233)			
Once	9(3.9)	2(22.2)	7(77.8)
Twice or more	224(96.1)	120(53.6)	104(46.4)
What is used to wash the genital area (n = 233)			
Water only	110(47.2)	59(53.6)	51(46.4)
Water and soap	123(52.8)	63(51.2)	60(48.8)
Source of water used to wash the genital area (n = 232)			
Borehole (BH)	125(53.9)	64(51.2)	61(48.8)
Hand-dug well (HDW)	104(44.8)	56(53.8)	48(46.2)
Surface water	2(0.9)	0(0)	2(100)
Packaged (Sachet) water	1(0.4)	1(100)	0(0)
Privacy: where you change absorbent material at home (n = 233)			
Bath/washroom	70(30.0)	44(62.9)	26(37.1)
Bedroom	74(31.8)	45(60.8)	29(39.2)
Toilet (Flush or latrine)	89(38.2)	33(37.1)	56(62.9)
Privacy: Do you change your absorbent material when away from home (n =233)			
Yes	125(53.6)	64(51.2)	61(48.8)
No	108(46.4)	58(53.7)	50(46.3)
Privacy: where you change absorbent material when away from home (n = 125)			
Bathroom	10(8)	7(70)	3(30)
Another room in the location	21(16.8)	19(90.5)	2(9.5)
Outside (field/bush)	21(16.8)	12(57.1)	9(42.9)
Toilet (Flush or latrine)	73(58.4)	26(35.6)	47(64.4)

Table 1-5. Gendered water-related illnesses in Abeokuta, Nigeria

Water-related illness	Women (n= 7151)	Men (n= 2878)	Girl (n=6397)	Boy (n=5890)	Total no. of cases (n= 22316)
	n(%)	n(%)	n(%)	n(%)	n(%)
Malaria	4744 (29%)	2095 (14%)	4369 (29%)	3995 (28%)	15203 (68.1%)
Typhoid Fever	850 (58%)	300 (17%)	222 (10%)	172 (15%)	1544 (7.0%)
Diarrheal disease	113 (14%)	25 (5%)	281 (34%)	301 (46%)	720 (3.2%)
Gastro-Intestinal Tract Infection	335 (40%)	100 (13%)	198 (29%)	167 (18%)	800 (3.6%)
Upper Respiratory Tract Infection	656 (22%)	268 (8%)	1174 (36%)	1126 (34%)	3224 (14.4%)
Pelvic Inflammatory Diseases/ UTI	336 (68%)	36 (9%)	35 (13%)	17 (11%)	424 (1.9%)
Skin Infections	117 (30%)	54 (11%)	118 (28%)	112 (30%)	401 (1.8%)

Table 1-6. Potential health risk exposure of hydro chemicals (metals) in water sources, Abeokuta City, Nigeria

Hydro chemicals	Water sources	Hazard Index (HI)			
		Women	Men	Girls	Boys
Ca *Rfd = 0.001*	HDW	1679	1951	1853	1984
	BH	2515	2921	2774	2971
	STW	784	911	865	926
	SW	2062	2396	2275	2437
Mg *Rfd = 1.1*	HDW	0.31	0.36	0.34	0.37
	BH	0.45	0.52	0.49	0.53
	STW	0.13	0.15	0.15	0.15
	SW	0.26	0.30	0.28	0.30
Fe *Rfd = 0.7*	HDW	0.00096	0.00111	0.00105	0.00128
	BH	0.00096	0.00111	0.00105	0.00113
	STW	0.00064	0.00074	0.00070	0.00075
	SW	0.00032	0.00037	0.00035	0.00038
Mn *Rfd = 0.14*	HDW	0.014	0.017	0.016	0.017
	BH	0.030	0.035	0.033	0.036
	STW	0.027	0.031	0.030	0.032
	SW	0.016	0.019	0.018	0.019
Zn *Rfd = 0.03*	HDW	0.003	0.004	0.003	0.004
	BH	0.002	0.002	0.002	0.002
	STW	0.001	0.001	0.001	0.001
	SW	0.002	0.003	0.003	0.003
Cr *Rfd = 0.01*	HDW	0.000297	0.000345	0.000328	0.000351
	BH	0.000297	0.000345	0.000328	0.000351
	STW	0.000297	0.000345	0.000328	0.000351
	SW	0.000148	0.000172	0.000164	0.000175

Rfd – measured in mg/kg/day; HDW – Hand-dug well; BH – Borehole; SW – Surface water; STW – Sachet water.
HI values in red (highest values) and wine color are above threshold limit of 1.0.



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225 East Beaver Creek Road
Richmond Hill, Ontario L4B 3P4, Canada

Tel: +905 667-5511
Fax: +905 667 5510

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