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Research Article

Risk Factors of Diarrhoea Among Under-Five Children in Zimbabwe: A Systematic Review

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Abstract

Introduction: Children are at a higher risk of succumbing to diarrhoea. Zimbabwe remains one of the countries topping in terms of morbidity and mortality due to diarrhoea diseases among under-fives. This study aims to determine factors affecting diarrhoea among under-five children in Zimbabwe.

Methodology: A systematic review was executed based on searches from six databases. All types of studies published between 2018 and 2022 in English about diarrhoea disease and among children under the age of five in Zimbabwe were included. Seventeen articles met the requirements of this study. All the data was inputted onto a data extraction sheet and thematic analysis was carried out on the study outcomes to identify themes.

Results: Diarrhoea risk factors can be categorized into two main themes; modifiable and non-modifiable diarrhoea risk factors. Under the modifiable risk factors are four subthemes: environmental, socio-economic, behavioural, and modifiable biological diarrhoea risk factors. Under the non-modifiable risk factors are two sub-themes: age and gender. For any Water, Hygiene and Sanitation (WASH) intervention to succeed, these risk factors should be present at optimum. If any of the factors is not optimally present, WASH interventions must concurrently address the risk factor or else the intervention is predestined to fail.

Conclusion: WASH remains an important issue in Zimbabwe as a tool to improve the lives of children under five years old. There is a necessity to investigate why certain interventions work well in other low-income countries and not Zimbabwe. All WASH interventions must make a thorough baseline assessment of conditions present on the ground to ensure the success of interventions.

Keywords: Water, Sustainable development goal, Diarrhoea, Children, Risk factors, Zimbabwe

Introduction

Water, Hygiene and Sanitation (WASH) represents a global movement aimed at the improvement of lives through the prevention of WASH-related diseases [1,2]. Inadequate WASH remains a major global risk and an important determinant of disease burden [3]. An estimated 1.42 billion people including 450 million children live in areas with water scarcity of different extremes; 3.6 billion people lacked safely managed sanitation services and 2.3 billion people lacked basic hygiene services [4,5]. Children are at a higher risk of succumbing to diarrhoea because of their small bodies-they are at higher dehydration and loss of electrolyte risk [6-8]. The disease also has negative effects on child growth, cognitive development, and metabolism [9,10].

The WASH situation is made dire by the fact that only 3% of water bodies are freshwater sources and are fast dwindling due

to decades of mismanagement, contamination, over-extraction of groundwater, climate change and extreme weather conditions. The WASH demand is at the same time fast increasing due to urbanization and rapid population growth. A combination of these is putting children at greater risk threatening decades of gains that have been made in child survival and sustainable development [5]. The global rate of under-five mortality has dropped by a significant 60% from the previous 93 deaths per 1000 in 1990 to 37 deaths per 1000 in 2020 [11]. This drop has, however, not been equitable because Sub-Saharan Africa (SSA) continues to experience huge mortalities- it hosts 85% of the world's premature deaths [11]. A great number of people still lack these basic amenities, and the world is not on track to achieve this sustainable development goal [12-14]. The African region has the largest burden of disease yet receives the lowest services. By 2020, 80% of people who still lacked basic drinking water services lived in rural areas and half of these were in the Least Developed Countries (LDCs). The overall estimation for open defecation in Sub-Saharan Africa is 22.55% and in Zimbabwe it is 22.75% of the population. A majority of these are in rural areas. There is also a gap between high and low-earning nations in terms of hygiene with LDCs ranking lower [5].

Zimbabwe has the highest heterogeneity morbidity and mortality that are attributable to Escherichia Coli and Shigella infection among other African countries [15]. The World Bank reports that deaths attributed to unsafe water, lack of sanitation and poor hygiene stand at 24.6 per 100 [16]. This figure is very high compared to, for instance, Australia which stands at 0.1, the United Kingdom (UK), the United States of America (USA) stand at 0.2 and South Africa at 13.7%. The prevalence of diarrhoea in children under 5 in Zimbabwe was recorded to be 15% in 2019, which was, in fact, its recorded lowest figure yet recorded. The figures can be as high as 30% and 25% as recorded in 1995 and 2015 respectively. To achieve equitable access to WASH, there is a need to pay special focus to the most disadvantaged population. It is estimated that interventions implemented with 99% coverage could reduce diarrhoea incidence by 30% [17]. The United Nation's Sustainable Deployment Goal 6 (SGD6) is about ensuring access to water and sanitation for all [14]. Several interventions themed around this SDG 6 have been undertaken in Zimbabwe. To the best of our knowledge, there has not been a systematic review done on this topic in Zimbabwe. This necessitated carrying out this systematic review to compile the outcomes of the programs that make use of SDG6 on child diarrhoea diseases in Zimbabwe.

Methodology

Search Strategies

This systematic review is reported using The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), 2020 guidelines [18]. Six databases were searched for articles, these are Scopus, CINAHL, PubMed (Medline), MBASE (Semantic Scholar), ProQuest and Science Direct. The choice of databases was informed by their popularity and accessibility [19]. The searches were conducted using combination keywords derived from the topic and substitute (synonymous) words. Boolean operators "AND" and "OR" were applied in combination to keywords as follows: ("water and sanitation" OR "water" OR "sanitation" OR "hygiene") AND ("Zimbabwe" OR "Africa" OR "Sub-Saharan Africa") AND ("child*" OR "young" OR "infant*") AND ("diarrh*" OR "waterborne" OR "water-borne disease").

Inclusion and Exclusion Criteria

To be included, each article had to meet the inclusion criteria. The studies had to be published in English; on WASH; diarrhoea disease; children under the age of five and Zimbabwe. The full text should be accessible and published between 2018 and 2022. All qualitative, quantitative, and mixed-approach studies were included in the study while systematic review articles were excluded.

The Selection Processes

After searching, all titles and available abstracts from each database were copied to a Word document. They were each subjected to a screening process by reading the titles and removing irrelevant publications. Duplicated titles, systematic reviews and meta-analyses were removed. Of the 2,463 search results, 116 made it to the first list of relevant materials and these were further screened by reading abstracts and further removal of those that did not fit the inclusion criteria. From this, a list of 19 publications was compiled. Of the 19, the full texts for 17 articles were accessed and two whose full texts could not be accessed were removed. The PRISMA flow chart in Figure 1 shows the systematic steps taken to arrive at the 17 articles (Figure 1).

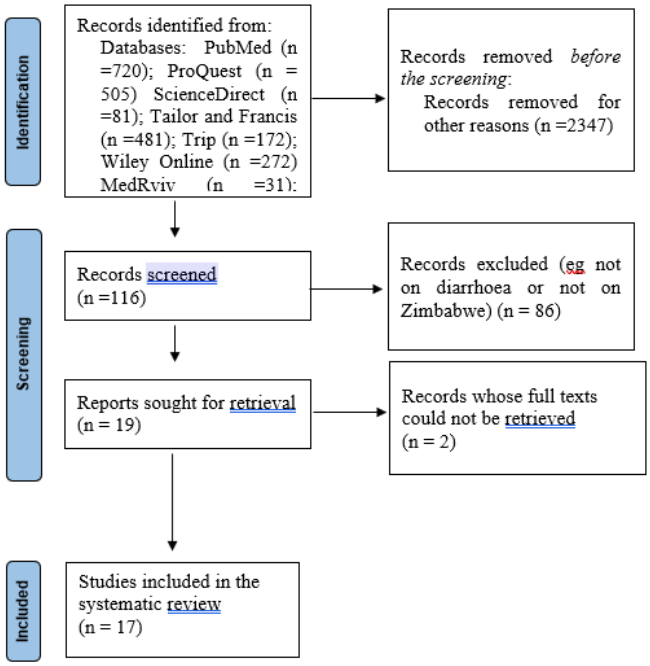

Figure 1: The search process.

Data Extraction and Charting

The data from the included articles were recorded onto a Data Extraction Sheet (DES) designed to capture essential details of the studies. The DES provides the foundation for appraising, analyzing, summarizing, and interpreting the body of evidence. It helped minimize errors in extracting themes by bringing the information into one place and making it manageable [20].

The studies were checked for quality using the Critical Appraisal Skills Program (CASP) checklist. Each study was checked for satisfying at minimum questions: "Did the study address a focused research question?; "Were participants recruited ethically?"; "Were appropriate methods used to address this issue?"; "Were the effects of intervention reported comprehensively?"; "Can the results be applied to the local population?"; "Were the exposure and outcome accurately measured to minimize bias?"; "Where confounders accounted for?"; "What are the results and how precise are they?"; "Are the studies' results valid?" and "Do these results fit within available evidence?" [21]. Each study was subsequently subjected to questions that are specific to each study design employed as provided for by CASP. These questions were satisfied in all the included studies. The studies were then recorded in a data extraction sheet Table 1.

Synthesizing Results

The results of the included studies were read and scrutinized for a thorough understanding. Codes were created and common concepts or meanings were arranged into groups under these codes. Themes were then subsequently derived based on these groups of common concepts and meanings. Thematic analysis, a method that is based on the criteria of recurrence, repetition, and forcefulness, is widely used in qualitative data analysis [22-24] (Table 1).

Table 1: Data extraction sheet.

Authors (Year) Title	Aim of Study	Target Groups / Participants	Methodology	Results/ Key Findings
Church JA, et al., (2019a) [25]	To explore associations between enteropathogens and RVV immunogenicity and evaluated the effect of improved WASH on enteropathogen carriage.	224 infants with enteropathogen and immunogenicity data	Quantitative: Cluster randomised 2x2 factorial trial	Improving household WASH during the period did not reduce diarrhoeal incidences. Rotavirus vaccines are not effective in Low-Income Countries as they are in High-Income Countries possibly due to continued exposure to infections.

Gona PN, et al., (2020) [26]	To examine changes in ORS coverage in Zimbabwe, Zambia and Malawi. Covering at least 15000 children.	Under 5 children	Quantitative: Comparative analysis stratified two-stage cluster sampling	The provision of safe water, sanitation and hygiene reduces cases of diarrhoea in children under 5. Improved access to medication, vaccines (Rotavirus and Cholera) and promotion of the use of ORS reduce disease incidences.
Russel F and Azzopardi P, et al., (2019) [27]	Editorial comment	Children under 5	Qualitative: Comment/ Qualitative	WASH improves common causes of diarrhoea and a plethora of other diseases. Invest in WASH to address poor growth and nutrition. Children with poor nutrition are vulnerable to diarrhoea.
Mkandla S, et al., (2018) [28]	To examine conditions in Umzingwane district that may have led to an uptick in diarrhoea cases among under-fives in 2016	Under 5 in Umzingwane District who had diarrhoea in 2016	Quantitative: Survey/ Unmatched Case-control	Risk factors: water source, disposal of waste, household hygiene, Water source, Disposal of waste, Household hygiene, Hand washing practices, Food storage, Vaccination status. Protective factors: Improved household income, and caregiver knowledge.
Pickering AJ, et al., (2019) [29]	To ascertain if water quality, sanitation, and handwashing (WASH) in a household are strongly associated with the linear growth of children living in the same household.	Households in Kenya, Zimbabwe and Bangladesh	Quantitative: Randomised efficacy trials	WASH intervention did not reduce diarrhoea in Zimbabwe, but it did in Bangladesh. WASH does not affect linear growth, Poor baseline sanitation is a strong risk factor for diarrhoea.
Tusting LS, et al., (2020) [30]	To ascertain the effects of housing and child health in sub-Saharan Africa	824,694 children between 0-5 years surveyed in 54 Demographics	Quantitative: Lab-Based Testing WASH Efficacy trial	Poor housing, inadequate drinking water, poor sanitation and hygiene are associated with childhood diarrhoea.
Moyo TM, et al., (2022) [31]	To investigate the risk factors associated with this outbreak to recommend prevention and control measures.	All ages people	Quantitative: 1:1 unmatched case-control study, Interviews, hospital records; surveillance records.	Risk factors: Being under-five years old, drinking borehole water, Storing water in open containers Interventions: Education on home water treatment, Distribution of water containers, Distribution of Aqua tabs
Musuka G, et al., (2021) [32]	To understand the factors associated with diarrhoea as well as describe determinants for seeking medical treatment in children under-five in Zimbabwe	children under-five	Quantitative: Cross-sectional Study Random Sampling Multiple Indicator Cluster Survey	Poor drinking water sources are a risk of diarrhoeal infections. Diarrhoea is lower in female children. Diarrhoeal incidences decrease with parental education and wealth.

Koyuncu A, et al., (2020) [33]	To examine variability in the association between household flooring and diarrhoeal illness by water and sanitation	Infants 9-18 months of age	Mixed: Survey, Interviewer observation, Cross-sectional Data collected in previous research	Improved floors reduced diarrhoeal incidences within four weeks. It is a speedy way to break the diarrhoeal pathogens pathway that does not require behavioural change. The association between the flooring and diarrhoeal illness did not vary by the presence of improved/ unimproved water
Humphrey JH, et al., (2019) [34]	Assessment of the independent and combined effects of improved water, sanitation, and hygiene, and improved complementary feeding, on child stunting and anaemia	Children between ages 12 and 18 months.	Quantitative: Cluster-randomised, 2×2 factorial trial	The WASH intervention affected neither the primary outcome nor did it reduce the prevalence of diarrhoea at 12 or 18 months. Household-level WASH interventions in rural areas of Zimbabwe are unlikely to reduce diarrhoea and stunting.
Dietler D, et al., (2021) [35]	To quantify the impacts of mining projects on access to water and sanitation infrastructure as well as diarrhoea and malnutrition among children using data from 131 Demographic and Health Surveys from sub-Saharan Africa.	1.2 million households, data within the proximity of 52 mine-panels and 41,896 households with 32,112 children	Quantitative: Use of merged Data from ZDHS and Standard and Poor's (S&P) Global Market Intelligence Mining Database	There was improved water and sanitation access among households close to mining sites. Lower improvement in water and sanitation access among poorer households. No changes were seen for wasting and diarrhoea. Opening mines is associated with improving SDG6 and SDG3
Church JA, et al., (2019a) [36]	To explore associations between enteropathogens and RVV immunogenicity and evaluated the effect of improved WASH on enteropathogen carriage.	224 infants with enteropathogen and immunogenicity data	Quantitative: Cluster randomised 2x2 factorial trial	Improving household WASH during the period did not reduce diarrhoeal incidences. Rotavirus vaccines are not effective in Low-Income Countries as they are in High-Income Countries possibly due to continued exposure to infections.
Apanga PA, et al., (2021) [37]	To assess whether access to an improved water supply and water-fetching were associated with mothers' practice of exclusive breastfeeding.	247 090 mothers with children 5 months old or less	Mixed: Secondary Data Zimbabwe Demographic and Health Survey (ZDHS), Interviews, Biomarker Testing.	Exclusive breastfeeding reduces diarrhoea incidence. Women spend much time fetching water reducing time for breastfeeding
Cumming O, et al., (2019) [38]	To report key consensus messages as a basis for wider discussion and debate in the WASH and nutrition sectors.	Consenting pregnant women residing in the study areas were enrolled, together with their children in utero, and then followed up for between 18 and 24 months.	Quantitative: Cluster-based randomized controlled trials	These specific interventions had neither influence in settings where stunting remains an important public health challenge on linear growth. Basic WASH services alone are unlikely to have a large impact on childhood stunting.

Makasi RR and Humphrey JH., (2020) [39]	To test the independent and combined effects of improved household WASH (improved pit latrine and handwashing station not connected to a water source, point-of-use water chlorination) on child linear growth.	More than 15,000 children at 18 months (SHINE) or 24 months (WASH Benefits trials) of age.	Quantitative: Cluster Randomised control Trial	WASH intervention failed to reduce enteropathogen exposure among the study population. WASH intervention did not have any observed effect on the linear growth of the children
Prendergast AJ, et al., (2019) [40]	To test the effect of improved infant and young child feeding (IYCF) and improved water, sanitation, and hygiene (WASH) on child linear growth and haemoglobin concentrations	668 HIV-exposed children under 5 in 2 districts in rural Zimbabwe	Quantitative: Cluster randomised 2×2 factorial trial	WASH did NOT lead to improved growth in HIV-positive children but IYCF had.
Rogawski Mcquade ET, et al., (2020) [41]	To assess the impact of WASH and IYCF interventions on enteric infections SHINE trial in rural Zimbabwe.	Children 1,3,6, and 12 months of age	Quantitative: Lab-Based Testing WASH Efficacy trial	The intervention had no effect on diarrhoeal prevalence. WASH decreased pathogen numbers detected.

Results

The characteristics of the included studies are shown in Table 2. Twelve of the studies (70%) were carried out between 2019 and 2020. Eighty-two percent of the studies were quantitative studies while two were mixed method and one qualitative. Of the quantitative studies, the dominating method was the cluster randomized control trial used in seven of the research while three relied on data from the Zimbabwe Demographic Health Survey. Eleven of the studies targeted children under five with one of the studies targeting children with HIV while another was aimed at children whose heterogeneity and immunogenicity data was known while the other six included mothers or entire households in the sample. Of the included studies, it was found that eight of the research emanated from a major cluster randomized 2×2 factorial trial research that was carried out in Zimbabwe over a period of two years (Table 2).

Table 2: General characteristics of the studies.

Variable	Frequency	Percentage (%)
Year of Study		
2018	1	6
2019	6	35
2020	6	35
2021	3	18
2022	1	6
Study Design		
Quantitative studies	14	82
Mixed methods study	2	12
Qualitative studies	1	6
Target Group		
Children under 5 years (Only)	11	64
Mothers and children under 5	3	18
Entire households and their Children under 5	3	18

Themes Identification

After synthesizing the results, two main themes were identified including modifiable and non-modifiable determinates of diarrhoea (Table 3).

Table 3: Themes identified from the included papers.

Theme	Sub-Theme
Modifiable diarrhoeal risk factors	Environmental factor Socio-economic factors Behavioural factor Biological co-factors
Non-Modifiable diarrhoeal risk factors	Age Gender

For WASH interventions to succeed or fail in the reduction of diarrhoea disease among under-fives, there are always other accompanying factors at play to either complement or undermine the intervention. To achieve success, WASH interventions, and targets, counter or complement these factors. There are modifiable risk factors and non-modifiable risk factors. A combination of individual effects of environmental, socio-economic, behavioural, and biological grounds the success or failure of WASH interventions that target under-fives in Zimbabwe. When the risk factors are present at optimum, WASH interventions alone succeed in reducing diarrheal disease among under-five children. Three studies demonstrated this, [25-27] found that when nearly all the factors are optimum, improvements in household WASH led to a significant reduction in cases of diarrhoea as well as improved increases in seroconversion to Rotavirus Vaccine in rural Zimbabwean infants. Likewise, Russel and Azzopardi established that WASH improves common causes of diarrhoea and a plethora of other diseases [27].

Modifiable Diarrhoea Risk Factors

These are diarrhoea risk factors that can be controlled.

Environmental Risk Factors: The environmental risk factors include the intervention location conditions, waste disposal, water source, state of housing, and floors. A total of nine (9) of the included studies carried out this theme. The indiscriminate disposal of human waste contributes to environmental risk factors [28,29]. Additionally, Pickering, Tusting, et al., both suggest that poor baseline sanitation, kitchen hygiene and food storage were strong risk factors for diarrhoea [29,30]. Poor sources of drinking water such as boreholes and open containers are key contributors to diarrhoea disease among children of the age [31,32]. Housing is an important environmental factor for diarrhoea disease with children from highly populated households with poor housing being more vulnerable to diarrhoea. In their study, *Tusting, et al.,* found an association between increased diarrhoea incidences and poor housing [30]. found that Poor flooring was found to provide a pathway to diarrhoea pathogens hence improving flooring breaks this pathway [33].

A geographical location such as rural, urban, or country is an important environmental factor that can determine the success or failure of an intervention. Houses located in rural areas and away from economic activities have a lower chance of improvement in diarrhoea incidence (and subsequently child stunting) from WASH interventions alone [34]. Two studies agree that households located in the immediate proximity of improved or new economic activities, particularly mining, experience an improvement in water supply and sanitation access [30,35]. A WASH intervention by *Pickering, et al.,* did not reduce diarrhoea and the number of infections in Zimbabwe but a similar one implemented in Bangladesh yielded positive results [29]. In another study by *Church, et al.,* contrary to expectation, the Zimbabwe WASH intervention did not improve Rotavirus Vaccine efficacy among children. During a Rotavirus Vaccination drive in Zimbabwe, the incidences of children with diarrhoea diseases did not reduce even with the cohort that received improved WASH. It was concluded that Rotavirus vaccines are not effective in Low-Income Countries as they are in High-Income Countries even with improved WASH. This is possibly due to recurring infections among the population [36].

Socio-Economic Risk Factors: The socio-economic factors including parent education, caregiver knowledge and poverty are associated with lower health-seeking behaviors and attitudes and in turn increase the risk of diarrhoea diseases among under-fives in Zimbabwe. This was found in four (4) studies in total. Positive outcomes were found to be significantly biased towards households that have higher family wealth and parental education [32,35]. Poorer households did not experience changes in wasting and diarrhoea incidences because of lower improvement in their WASH situation among new mining areas. Parental and caregiver education is a key intervention to improve success in WASH [31]. A combination of improvements in household income and caregiver knowledge increases WASH efficacy [28].

Behavioural Risk Factors: Four (4) studies had this theme in common. Behavioural factors that encourage diarrhoea occurrence include poor household hygiene practices, handwashing practices, food storage practices, health-seeking behaviours, and waste disposal practices. Health-seeking behaviour such as vaccination of children is related to diarrhoea occurrences in that vaccinated children are less likely to develop diarrhoea if WASH is improved [28]. In addition to improving WASH among children, behavioural patens such as improved seeking and access to medication, vaccination (Rotavirus and Cholera) and promotion of Oral Rehydrating Solu-

tions (ORS) use, reduces the case of diarrheal disease among under 5 children [26]. Water treatment with aqua tabs is a behaviour that will reduce diarrhoea occurrences [31]. Exclusive breastfeeding behaviour reduces diarrhoea risk among the children of that age group, yet women spend a lot of their time traversing to fetch water because of the large distances between homes and water sources. This, therefore, reduces breastfeeding time and the likelihood of exclusive breastfeeding. A combination which increases the diarrhoea risk among breastfeeding children [37].

Biological Co-Factors: Four (4) studies produced this theme. The biological factors that aid diarrhoea occurrence in children under five include HIV, wasting and stunting of the child [29,38-40]. Two found that their interventions had no influence on linear growth in settings where stunting remains an important public health challenge [29,38]. Current evidence suggests that basic WASH services alone are unlikely to have a large impact on childhood stunting, which is a biological determinant of diarrhoea disease [38]. WASH alone had no effect on the reduction of diarrhoea occurrences and growth among HIV-positive children as compared to those, among them, receiving improved Infant and Young Child Feeding (IYCF) *Prendergast, et al.,* (2019) [40]. In one intervention, wash did not manage to reduce enteropathogenic exposure to facilitate linear growth-there was no effect on the linear growth of any of the children under WASH [39].

Non-Modifiable Diarrhoeal Factors

These are diarrhoea risk factors that cannot be controlled at the level of the researcher. The non-modifiable biological risk factors for diarrhoea are age and sex. This theme is found in a total of three (3) of the included papers.

Age: Two (2) papers produce this theme. Being under five years of age is a risk factor for diarrhoea disease [31]. In one study, WASH intervention did not have any effect on diarrhoea prevalence among under-fives but decreased the number of pathogens detected [41].

Gender: One study produced this theme. Boys are at a higher risk compared to girls-diarrhoea occurrences are higher in boys than it is in girls [32].

Discussion

The research confirms there is an adverse relationship between low water, sanitation, and hygiene availability in the fight against diarrhoea diseases among under-fives in Zimbabwe. Many families still with no access to clean drinking water, practice open defecation and lack facilities to practice handwashing [5]. The combination of these continues to cause the proliferation of diarrhoea diseases among under-five children in Zimbabwe. The systematic review found that factors that are causative to diarrhoea diseases among under-fives in Zimbabwe are biological, environmental, socio-economic, and behavioural and can be categorized into modifiable and non-modifiable diarrhoea risk factors. It was, likewise, found that not all WASH interventions targeting these factors produce the expected results.

Research on WASH has a long history such that there is a plethora of interventions targeting different facets of childhood development. Introduction of improved WASH, for instance, was found to be a reducing factor for anemia in children [42,43]; a positive association between improved WASH and better growth outcomes in children [42,44,45] and poor conditions of WASH are associated with 6.6% of global disease and disability [3,17]. In Zimbabwe, *Chandna, et al.,* found that combining Infant and Young Child Feeding (IYCF) and WASH interventions significantly improved motor, language, and cognitive development in HIV-exposed children [46]. WASH in settings such as schools reduce days of absenteeism [42,47,48].

The findings in this review are like those found in some other research carried out before the included period. In a systematic review by *Cairncross, et al.,* for instance, it was found that hand-washing behaviour using soap influences pathogen transmission, and this is dependent on water availability [49]. The reduction of diarrhoea diseases is possible with the provision of an environment with point-of-use clean drinking water alone, but the effect is much more pronounced when the intervention is done combined with the provision of sanitation [50-52]. The promotion, formation, resuscitation, and empowerment of WASH in the community and schools are important in fostering behavioural change to promote disease prevention [42,48,53]. Diarrhoea risk factors include peri-urban settings, waste disposal practices, use of untreated water and sharing of toilets [54]. The higher association between diarrhoea and boys is not thoroughly understood, several hypotheses, such as cultural and environmental factors, or sex-based biological factors, have emerged to explain the variance [55].

WASH interventions that do not yield expected results are a rather puzzling result, but a valuable lesson. This is not unique there have been other research in other jurisdictions with similar outcomes, for instance in Jordan, the provision of clean water alone did not affect the prevalence of diarrhoea among children. Improvements only occur when sanitation is simultaneously improved [56]. This can be explained by the existence of confounding factors [57]. Rotavirus vaccines were found NOT to be as effective in low-income countries (Zimbabwe) as they are in high-income countries possibly due to continued exposure to diarrhoea infections [25,36].

According to *Rogawski-McQuade, et al.,* raises methodological concerns in WASH research [58]. They state that the estimated effects of treatment in two different study designs (observational studies and trials) bring disparities in results. The Population Intervention Effects (PIE) were always smaller than the Average Treatment Effect (ATE), and the magnitude of the difference depended on the baseline prevalence of the improved sanitation. They concluded that the effects underestimation may in part explain the inconsistencies in results between the observational associations and null trial results. The use of observation ATE in setting expectations for trials may overestimate the impact of the interventions. They say PIEs predict realistic effects and should be more routinely estimated.

Methodological issues are also raised by Headey, *Palloni, et al.,* in explaining differences in results in interventions [59]. They aver sanitation interventions can only account for 10% of child mortality between 1990 and 2015 in data from 59 countries across the globe despite some interventions estimating the figure to be much higher than this. They say experimental literature on WASH interventions has inconsistencies in child health outcomes. The literature in general shows robust impacts on diarrhoea and related symptoms. Observational research exploiting cross-sectional variation in Water and sanitation is much more optimistic, finding strong associations with diarrhoea prevalence, mortality, and stunting. Both bodies of literature, in practice, suffer significant methodological limitations (p 729). Experimental WASH evaluations are often subject to poor compliance, rural bias, and a short duration of exposure, while cross-sectional observational evidence may be highly vulnerable to omitted variable bias [59].

On these 'unexpected' results, *Cumming, et al.,* comments that the results do not show that WASH cannot influence child linear growth, they only demonstrated that these specific interventions did not influence the settings. The biological plausibility of WASH is not challenged by the absence of expected results and no large population-level gains in child health have been achieved without improvement in WASH [39]. Children carrying water home were found to be associated with higher odds of diarrhoea disease in forty-nine Multiple Indicator Cluster Surveys from 41 countries [60]. In this research, it was concluded that the number of people using improved sanitation is seemingly more important than the type of toilet use. The percentage must be high to observe an improvement in association with reduced diarrhoea and death in children. They aver that at least 60% of access to improved sanitation was associated with reduced diarrhoea and acute undernutrition, while 80% of access was associated with a reduction in childhood death and stunting. They agree that access to water on premises and universal (or near-universal) access to sanitation has a positive association with improvements to maternal and child health.

Study Limitations

What works in WASH is poorly understood, and there is an argument for not using diarrhoea as a primary outcome to evaluate WASH [61]. Measuring diarrhoea might not be an accurate measure of changes in gastrointestinal health. Evaluation of community interventions normally utilizes lab results and yet WASH interventions rely on self-reporting. There is a danger of misclassification and bias due to the existence of non-infectious diarrhoea as well as asymptomatic infections. Furthermore, under the framework of SDGs, there is still a paucity of cross-country comparative research regards to the association between child disease, mortality, and water. Clinical secondary data that was used in the systematic review may contain biases and errors because it was gathered to answer research questions that may not be in line with the research in which they were ultimately used.

Conclusion

Zimbabwe is still lagging far behind in the achievement of SDG6 as families are still struggling to access clean water and accessing basic sanitation and hygiene infrastructure. This situation is detrimental to children's health and particularly those under five as they are prone to diarrhoea diseases. This review found that several factors contribute to under five diarrhoea situations present on the ground. These are the modifiable and non-modifiable factors. The modifiable is the environmental, socio-economic, behavioural, and modifiable biological co-factors, while the non-modifiable risk factors are age and gender. When all these risk factors are available at optimum, WASH interventions succeed. This entails that each WASH intervention, to succeed, should target, counter, or complement one or some of these risk factors. The mere provision of WASH alone does not guarantee favourable results.

Focused research is needed to establish what conditions cause some WASH interventions to fail yielding desired results in Zimbabwe while they do in other settings. This entails more robust baseline research before future WASH interventions. Enhanced and targeted education and community involvement will address the gaps caused by the risk factors through capacity building and knowledge transfer. Interventions that are more radical and with better precision on under-five children with HIV, stunted and male are needed. Zimbabwe needs to work towards establishing and then improving the factors that cause rural to have higher diarrhoea incidences than urban areas and for interventions to fail in Zimbabwe and succeed elsewhere. To achieve the SDG targets by 2030, Zimbabwe needs to strengthen its national policies by an increased investment through budgetary financing, allowing the private sector to invest in water and sanitation as well as establish and strengthen alliances with global partners. Else, as it stands, the SDG targets will not be achieved.

Conflict of Interest

None.

Acknowledgement

None.

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