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Water, sanitation and hygiene (WASH) in sub-Saharan Africa and associations with undernutrition, and governance in children under five years of age: a systematic review

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Review

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Abstract

Associations between different forms of malnutrition and environmental conditions, including water, sanitation and hygiene (WASH), may contribute towards persistently poor child health, growth and cognitive development. Experiencing poor nutrition in utero or during early childhood is furthermore associated with chronic diseases later in life. The primary responsibility for provision of water and sanitation, as a basic service and human right, lies with the State; however, a number of stakeholders are involved. The situation is most critical in sub-Saharan Africa (SSA), where, in 2015, 311 million people lacked a safe water source, and >70% of SSA populations were living without adequate sanitation. The aim of this paper was to conduct a systematic review to investigate the state of literature concerned with WASH and its association with nutritional status, and governance in children from birth to 5 years of age in SSA. Articles were sourced from PubMed Central, Science Direct and ProQuest Social Science databases published between 1990 and 2017. The PRISMA Statement was utilised and this systematic review is registered with PROSPERO (CRD42017071700). The search terms returned 15,351 articles for screening, with 46 articles included. This is indicative of a limited body of knowledge; however, the number of publications on this topic has been increasing, suggesting burgeoning field of interest. Targeted research on the governance of WASH through the identification of the various role players and stakeholders at various levels, while understanding the policy environment in relation to particular health-related outcomes is imperative to address the burden of child undernutrition.

Introduction

Undernutrition is a major public health concern because of associations with adult health and disease risk later in life, including among others, diabetes, hypertension and cardiovascular disease (CVD), and furthermore acts as a predictor of physical, mental and cognitive child development.[1–5] Experiencing poor nutrition in utero or during early childhood is furthermore associated with chronic diseases later in life. During the first 1000 days of growth and development, specific cells, organs and systems may be differentially affected by undernutrition.[6] Among the three primary forms of undernutrition – stunting, wasting and being underweight – stunting is the most prevalent in children under 5 years of age[7] and is defined as having a height-for-age z-score less than two standard deviations (SDs) of the median of the World Health Organization (WHO) Child Growth Standards.[8,9]

Undernutrition emanates from a variety of circumstances and determinants, including antenatal, intrauterine and postnatal malnutrition. The realisation that physical growth cannot completely be improved by optimised diet and reduced burden of infection has led to the hypothesis that linkages between different forms of undernutrition and environmental conditions, including water, sanitation and hygiene (WASH), may contribute towards persistently poor child growth and nutritional status.[10] Specific pathways are proposed by the so-called 5-F diagram, which describes the faeco-oral transmission route whereby faeces and associated pathogens are transmitted via fluids, fields/floors, flies and fingers to foods, and then to the infant which causes disease and infection which in turn leads to growth faltering.[11] Exposure to poor WASH during early childhood has been associated with higher risks of infections and poor nutritional status, including stunting.[12,13] Repeated infections in early life is associated with chronic low-grade inflammation[14,15] and associated CVD risks in adulthood.[16]

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Data from 140 Demographic and Health Surveys (DHS) in 65 countries reported that over half of the variation in child height between countries was explained by the frequency of open defecation. Another analysis of 171 surveys in 70 low- and middle-income countries (LMIC) found that increasing access to and use of improved water sources reduced the risk of stunting.[3,4,17] The situation is most critical in sub-Saharan Africa (SSA), where at the closing of the Millennium Development Goals cycle in 2015, the portion of people relying on untreated surface water for drinking was eight times higher than any other region. Furthermore, over 70% of the SSA populations were living without adequate sanitation and the absolute number of people practising open defecation actually increased.[18]

In response to these observations a number of trials, in various phases, have explored the effects of WASH interventions on nutritional status in children.[19–22] Initial results have indicated that there is only a marginal effect of WASH interventions on linear child growth.[21,23,24] In 2012, the WHO set ambitious global nutrition targets to reduce the number of children under the age of 5 that are stunted by 40% by 2025 with particular emphasis being placed on the role that WASH, financing and policy interventions will need to play in achieving these targets.[25]

The United Nations (UN) formally declared the right to water in November 2002 and noted that the right to water was indispensable to leading a life of human dignity and was furthermore a prerequisite for the realisation of other human rights. The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use. This also provided the first implicit reference to the responsibilities that governments and stakeholders have in delivering clean water and sanitation to everyone.[26] In the post-2015 agenda Sustainable Development Goals (SDGs) have been established, most notably in this regard SDG 6: Universal and equitable access to safe water and adequate sanitation (WASH); and SDG 2: End all forms of malnutrition, by 2030.[27,28] A key challenge to achieving the above SDGs is the unique combination of governance systems, stakeholder dynamics and institutional structures found in each country which manifest various problems and subsequent priorities.[29] Governance of WASH in this regard is the set of systems that are involved in decision-making about management and service delivery. Investigating the governance of WASH by disentangling the various actors, role players and stakeholders at various levels, while unravelling the policy environment is imperative to the understanding, design and implementation of WASH initiatives targeted at addressing the burden of childhood undernutrition.[25,27,30] The authors chose to conduct the review from 1990 onwards primarily due to the introduction of the United Nations Children's Fund (UNICEF) conceptual framework[31] which proposed a causal framework for maternal and child undernutrition which included WASH. In addition to this, the dramatic geopolitical shifts that occurred as a result of the ending of the Cold War, as signalled by the fall of the Berlin wall in 1989 had far-reaching consequences for the provision of basic services and healthcare, and transformed the dynamics of economic and health development at global, regional and national levels.[32,33] The rise of civil society and the movement on social justice, equity and rights significantly reshaped governance of health at all levels.[33,34] Furthermore, the Lancet Series on Maternal and Child Nutrition in 2013 provided an updated framework for maternal and child nutrition, as well as recommendations for inter-sectoral approaches to the challenges of malnutrition in LMIC settings, including WASH.[7,35] In order to explore this nexus, this systematic review aims to examine the literature linking WASH, childhood nutritional status and governance in sub-Saharan African settings.

Methods

Protocol and registration

A systematic review has been conducted to examine the governance of WASH in sub-Saharan settings and associations with nutritional status in children under 5 years of age. The PRISMA Statement[36] was utilised, while this systematic review has also been registered with PROSPERO (CRD42017071700).[37]

Eligibility criteria

Peer-reviewed articles published between January 1990 and October 2017 reporting governance or policy, WASH and associations with nutritional status in children in SSA were included. Studies pertaining to children with known chronic and acute diseases or abnormalities affecting growth were excluded along with publications not in English or French. In addition, a survey of government websites, the Global Database on the Implementation of Nutrition Action (GINA)[38] and, where possible, the Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)[39] was conducted to investigate whether countries in SSA had water and/or sanitation policies and if they included any links to health and/or nutrition.

Study identification and selection

Data were sourced from electronic databases. All combinations of the following keywords were used to select publications from PubMed Central, Science Direct and ProQuest Social Science databases published between January 1990 and October 2017: Governance, Policy, Management; Water, Sanitation, Hygiene, WASH; Undernutrition, Under-Nutrition, Under Nutrition, Malnutrition, Stunt-ed/ing, Underweight, Wast-ed/ing; Children, Infant, Under Five Years of Age, Preschool, Pre-school; Africa. The authors opted for selecting papers that reported governance, WASH and nutritional status irrespective of links between the various components. With regard to water and sanitation policies in SSA, government websites, the GINA,[38] and where possible, the GLAAS[39] were searched for relevant policies. The authors searched grey literature databases including the Grey Literature Report in Public Health,[40] African Index Medicus,[41] the WHO Virtual Health Sciences Library,[42] as well as conference proceedings and websites, and furthermore reviewed reference lists and where appropriate contacted experts and authors.

Data extraction

Using a standard data extraction sheet for all studies included in the systematic review, data pertaining to the governance or policy mechanism were extracted along with nutritional status as defined by the WHO Multicentre Growth Reference Study,[9] and WASH metrics as defined by the United Nations Joint Monitoring Programme (JMP).[43] Study design, date of data collection, country, participant age and sex, as well as sample size, aims and results or outcomes were also extracted. In terms of the policies that were sourced, excerpts pertaining to the country, policy and date, as well as links to health and/or nutrition were extracted using a standard data extraction form.

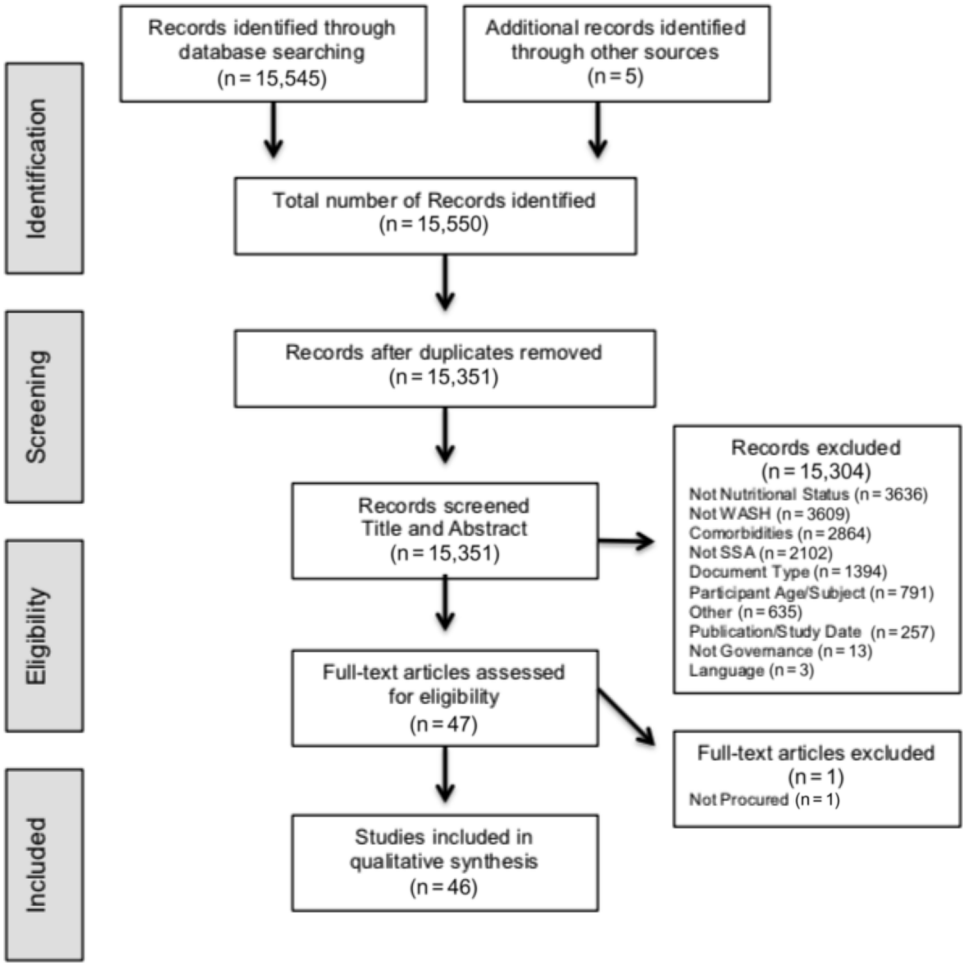

Fig. 1. Flow diagram.

Quality assessment and data analysis

For studies that were included, the strength of the individual articles and body evidence were assessed using the Grading of Recommendations, Assessment Development and Evaluation (GRADE) approach.[44,45] All studies were graded concerning their quality and summary data regarding data extraction fields, compiled. The studies included were assessed and classified to be of very low, low, moderate or high quality.

A synthesis of the eligible studies was compiled, and health policy and systems research – exploratory and descriptive frameworks utilised.[46,47] These sought to incorporate the context, content and processes surrounding knowledge production and act as a model for analysis.

Results

Description of publications

The search terms returned a total of 15,351 articles for screening as reflected in the flow diagram (Fig. 1), through which a total of 47 articles were identified for full-text review. Publications were excluded because: nutritional status was not reported ($n = 3636$), metric for WASH was not reported ($n = 3609$), comorbidities such as acute and chronic infections, congenital abnormalities or any condition that could affect growth was not reported ($n = 2864$), participant was >5 years of age ($n = 791$), publications did not geographically pertain to SSA ($n = 2102$), publication or date of study was not between 1990 and 2017 ($n = 257$), governance or policy mechanism was not reported ($n = 13$), publications were not in English or French ($n = 3$), the type of document was a newspaper, correspondence or book review ($n = 1394$), miscellaneous reasons ($n = 635$). One article could not be procured, thus 46 articles were included in the qualitative synthesis. For the purposes of this systematic review, the quality assessment yielded 3 publications of high quality,[7,35,48] 19 of moderate quality,[8,11,49–65] 24 of low quality[66–89] and none of very low quality.

Table 1 delineates the observational studies included in this systematic review while Table 2 indicates the reviews included. A total of 24 cross-sectional household surveys,[6,50–52,55–57,62,66,67,69–74,77–80,82–84,87] 14 reviews,[7,8,11,35,48,49,60,61,65,68,81,85,88,89] 4 cohorts,[58,59,63,75] 3 meta-analyses[53,76,86] and 1 case-control[64] studies were included (Fig. 2). The first publication documented dates from 1993[85] (Fig. 3). However, the period from 1993 to 2012 is characterised by a consistently low number of publications with a brief spike in 2008. There is a significant increase in the number of studies from 2013 to 2017.

Of the observational studies included, 30[50–59,62,64,66,67,69–72,74–80,82–84,86,87] aimed at assessing nutritional status and associated factors, while 2[63,73] were concerned with assessing the association between WASH and child growth. Water, either in terms of source, type of infrastructure or access, was reported as a significant risk factor in 21[50–52,57–59,63,66,69–71,74,76–80,82,84,86] of

Table 1. Studies included in systematic review

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance	Aim	Results
[50]	Nigeria	DHS	0–59 months	24529	HAZ	Water (Source and Type); Sanitation (Type)	Policy; Intervention planning	To determine the factors associated with stunting and severe stunting in children 0–23 months and children 0–59 months	Significant risk factors for stunting and severe stunting, among children aged 0–23 months and 0–59 months, included children who were reported to have had diarrhoea in the 2 weeks prior to the survey ([AOR] for stunted children 0–23 months = 1.22 [95%CI: 0.99, 1.49]); (AOR for stunted children 0–59 months = 1.31 [95%CI: 1.16, 1.49]), (AOR for severely stunted children 0–23 months = 1.31 [95%CI: 1.03, 1.67]); (AOR for severely stunted children 0–59 months = 1.58 [95% CI: 1.38, 1.82])
[80]	Ethiopia	Cross-sectional survey	0–59 months	605	HAZ; WAZ; WHZ	Water (Source and Type); Sanitation (Type)	Policy	To assess the nutritional status and associated factors in children <5 years of age.	Stunting was predicted by households where water was taken from unprotected sources (AOR, 2.13; 95% CI, 1.09–4.14).
[71]	Ethiopia	Cross-sectional survey	6–59 months	3108	HAZ	Water (Treatment); Sanitation (Access)	Policy	To review socio-demographic characteristics, and child anthropometry on potential immediate, underlying and basic individual and community-level determinants of child undernutrition using the UNICEF conceptual framework.	Household-level water treatment practice was associated with higher child height-for-age z-score by 0.25 SD ($P < 0.05$) compared to households that did not treat water at household level.
[70]	Tanzania	Cross-sectional survey	6–59 months	3280	HAZ	Water (Source and Type); Sanitation (Access)	Intervention planning	To explore factors associated with stunting among pre-school children.	Stunting was associated with access to improved water source (AOR: 0.70; CI: 0.52–0.93) and to a functioning water station (AOR: 0.63; CI: 0.40–0.98).
[79]	Congo; Ivory Coast; Ethiopia; Gambia; Mali; Mozambique; Namibia; Niger; Nigeria; Sierra Leone; Uganda; Zambia	DHS	0–59 months	Not available	HAZ; WAZ; WHZ	Water (Source and Type); Sanitation (Type)	Intervention planning	To explore the major question about the association between different household environment conditions with child survival and health	Improved water sources were significantly associated with lower odds ratio of stunting (0.77) and wasting in Uganda (0.50), while it was found significantly associated with lower odds ratio of underweight in Mali (OR = 0.768) compared to the use of non-improved water sources. Use of improved sanitation significantly associated with lower risk of underweight in the Congo Republic (OR = 0.821), Ethiopia (OR = 0.811) and Mali (OR = 0.768). It was also associated with lower risk of stunting in Cote d'Ivoire (OR = 0.709) and Ethiopia (OR = 0.854)

(*Continued*)

Table 1. (*Continued*)

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance	Aim	Results
[83]	SSA	DHS	12–36 months	33000	HAZ; WAZ	Water (Source); Sanitation (Access)	Policy	To consider the relationship between child malnutrition and selected bio-physical and macro-demographic variables combined with anthropometric data via geographic location	In unadjusted regression models, increased usage of well water and decreased usage of surface water were associated with a high share of underweight children. A complete lack of toilet and lack of flush toilet facilities were associated with a high share of underweight children. However, neither the infrastructure of water nor of sanitation were significantly associated with underweight in adjusted models
[52]	Tanzania	Cross-sectional household survey	0–59 months	7324	HAZ	Water (Source)	Intervention planning	To assess the determinants of stunting and severe stunting in children aged 0–23 months and 0–59 months	Most consistent significant risk factors for stunted and severely stunted children aged 0–23 and 0–59 months were: unsafe sources of drinking water (AOR for stunted children aged 0–23 months = 1.37; 95% CI: [1.07, 1.75]); (AOR for severely stunted children aged 0–23 months = 1.50; 95% CI: [1.05, 2.14]), (AOR for stunted children aged 0–59 months = 1.42; 95% CI: [1.13, 1.79]) and (AOR for severely stunted children aged 0–59 months = 1.26; 95% CI: [1.09, 1.46])
[53]	SSA	Meta-analysis	0–59 months	Not available	HAZ	Water (Type and Source); Sanitation (Type)	Policy; Intervention planning	To determine the risk factors for childhood stunting	Unimproved water and sanitation had the second largest estimated impact on stunting in SSA. Unimproved sanitation; OR 1.37: 95% CI (1.33, 1.41). Unimproved water source; OR 1.09: 95% CI (1.06, 1.12)
[87]	Ghana	DHS	0–59 months	2379	HAZ	Water (Source); Sanitation (Type)	Policy; Intervention planning	To examine the correlates of stunting	Source of drinking water and kind of latrine were used as independent variables in intermediate (environmental) factor model; however, only descriptive statistics were reported
[63]	Ethiopia	Cohort	0–59 months	7715	HAZ	Water (Access and Type); Sanitation (Type); Hygiene (Non-specific)	Policy; Intervention planning	To understand associations between water, sanitation and child growth	In unadjusted models, household access to improved water and toilets was associated with reduced stunting risk. After adjusting for child, household, parent and community variables, access to improved water was associated with lower prevalence of stunting and thinness at 1 year and 5 years. However, access to improved sanitation is more frequently associated with reduced stunting risk than access to improved water

[62]	Ethiopia	Cross-sectional household survey	6–24 months	587	HAZ; WHZ	Sanitation (Access)	Intervention planning	To assess stunting, wasting and associated factors among children aged 6–24 months	Unavailability of latrine was significantly associated with higher odds of stunting (AOR = 1.76; 95% CI: 1.17, 2.66)
[76]	SSA	Meta-analysis	0–59 months	Not available	WHZ	Water (Access)	Policy	To understand how social context affects the nutritional status of populations, as reflected by the prevalence of wasting in children under 5 years of age. To present a systematic way of building models for wasting prevalence, using a conceptual framework for the determinants of malnutrition and to examine the feasibility of using readily available data collected over time to build models of wasting prevalence in populations	Low birth weight, measles incidence and access to a safe water supply explained 38% of wasting in Africa
[55]	Ghana; Malawi; Tanzania; Nigeria; Zambia; Zimbabwe	DHS	1–35 months	Not available	WAZ	Water (Type); Sanitation (Type)	Policy; Intervention planning	To compare individual and household predictors of underweight among young children	At the household level, type of toilet facilities was associated with lower weight for age z-scores
[56]	Uganda	Cross-sectional household survey	0–59 months	104	HAZ; WAZ; WHZ	Sanitation (Access)	Policy	To investigate factors associated with malnutrition among under-five children	Proximate variables mediate demographic and socio-economic factors like the duration of breast feeding, sanitation and mothers health seeking behaviours to influence under-five malnutrition
[77]	Ethiopia	Cross-sectional household survey	0–59 months	1723	HAZ	Water (Access); Sanitation (Access)	Intervention planning	Aims at exploring the spatial distribution of stunting at meso- (district) scale and evaluates the effect of spatial dependency on the identification of risk factors and their relative contribution to the occurrence of stunting and severe stunting	Underlying factors for child undernutrition also include household and family-related factors such as food security, childcare, access to water and sanitation and lack of basic health services
[84]	Zambia	DHS	0–59 months	12714	HAZ	Water (Source and Type); Sanitation (Type)	Policy; Intervention planning	To investigate changes in socio-economic inequality in stunting and fever	Improved water source and improved toilet were not associated with a higher likelihood of stunting

(*Continued*)

Table 1. (*Continued*)

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance	Aim	Results
[73]	SSA	DHS	0–59 months	Not available	HAZ	Water (Type); Sanitation (Access)	Policy	To assess whether the importance of dense settlement for infant mortality and child height is moderated by exposure to local sanitation behaviour. Is open defecation worse for infant mortality and child height where population density is greater? Is poor sanitation is an important mechanism by which population density influences child health outcomes?	Open defecation externalities are more important for child health outcomes where people live more closely together. A one log-unit increase in population density increases the corresponding decline in height-for-age by about 0.04 SD of a height-for-age z-score
[54]	Kenya; Zambia	DHS	0–48 months	2500	HAZ; WHZ	Sanitation (Access)	Intervention planning	To determine the prevalence and determinants of stunting.	There was a higher risk of stunting in both Kenya and Zambia, for those with no formal toilet (OR = 0.80; 95% CI: 0.55, 1.15)
[58]	Kenya	Cohort	0–59 months	3335	HAZ; WAZ; WHZ	Water (Access); Sanitation (Access)	Policy; Intervention Planning	To investigate associations between nutritional status and individual-level factors, maternal factors, and feeding practices	The double burden of malnutrition in the urban slums may be occasioned by prevailing adverse conditions in these settings including poor livelihoods and low socio-economic status, high levels of food insecurity, poor access to water and environmental sanitation and healthcare services, high prevalence of infections (especially from diarrhoea, respiratory diseases), and poor child feeding practices in these settings
[74]	Somalia	Cross-sectional household survey	6–59 months	73778	HAZ; WAZ; WHZ	Water (Source)	Policy	To assess the spatial co-distribution of wasting, stunting and underweight and investigate their shared correlates	Access to foods with high protein content and vegetation cover, a proxy of rainfall or drought, were associated with lower risk of wasting and stunting. A 1-unit increase in enhanced vegetation index (EVI) was associated with a 38 %, 49 % and 59 % reduction in wasting, stunting and low mid-upper arm circumference, respectively. Children who had diarrhoea and acute respiratory infection in the past 2 weeks had a higher risk of wasting, stunting and underweight
[69]	Somalia	Cross-sectional household survey	0–59 months	73778	HAZ	Water (Source)	Intervention planning	To test a Bayesian hierarchical space-time model to forecast stunting using the relationship between observed stunting and environmental covariates	Rainfall and vegetation cover were significant in forecasting stunting. Rainfall (OR = 0.994, 95% credible interval (CrI): 0.993, 0.995) and vegetation cover (OR = 0.719, 95% CrI: 0.603, 0.858) were significant in forecasting stunting

[66]	Somalia	Cross-sectional household survey	6–59 months	73778	HAZ; WHZ	Water (Source)	Policy; Intervention planning	To investigate the predictors of wasting, stunting and among children aged 6–59 months	Effects of distal environmental covariates associated with vector-borne diseases on child growth outcomes were examined. These were rainfall, EVI, mean temperature, distance to water features and urbanisation. Fever, diarrhoea, sex and age of the child, household size and access to foods were significant predictors of malnutrition
[82]	Sierra Leone	Cross-sectional household survey	0–59 months	604	HAZ; WHZ	Water (Access); Sanitation (Access and Type)	Intervention planning	To assess the changing patterns of stunting and wasting in children 0–59 months	Stunting is associated with a number of immediate factors including (e.g., environmental, economic and socio-political factors) restricting access to safe and sufficient food and water
[75]	Ethiopia	Cohort	0–12 months	1065	HAZ; WAZ; WHZ	Sanitation (Type)	Intervention planning	To determine the prevalence and predictors of undernutrition among infants aged 6 and 12 months	Significant and consistent predictors of infant underweight, stunting and wasting, in both logistic and linear multiple regression models were poor household sanitary facilities
[59]	Gambia	Cohort	0–24 months	3659	HAZ; WAZ; WHZ	Water (Source); Sanitation (Access); Hygiene (Non-specific)	Intervention planning	To assess trends in growth faltering in children younger than 2 years	Underweight, stunting and wasting were was markedly seasonal, with greater deficits occurring in the rainy season when infections are more common. Amplitude of seasonal z-score fluctuation between birth and 2 years. HAZ (–0.09 [95% CI: –0.10 to –0.08]). WAZ (–0.15 [95% CI: –0.16 to –0.14]. WHZ (–0·16 [95% CI: –0.18 to –0.14])
[51]	Cameroon	DHS	0–59 months	1923	HAZ; WAZ	Water (Type); Sanitation (Type)	Intervention planning	To assess the association between explanatory factors and nutritional status and to estimate the net effects of both household and community factors	Improved household water and sanitation were associated with better HAZ and WAZ
[64]	Zimbabwe	Case-Control	0–24 months	14110	HAZ	Water (Type); Sanitation (Type); Hygiene (Non-specific)	Intervention planning	To test the effects of a single high-dose vitamin A supplement given to mothers and/or infants during the immediate postpartum period on several infant health outcomes	Non-exclusive breastfeeding has been associated with faeco-oral transmission of bacteria among infants living in conditions of poor sanitation and hygiene; frequent exposure to potentially pathogenic organisms likely drives the T-cell-mediated enteric inflammation that characterises environmental enteropathy
[78]	Tanzania	Cross-sectional household survey	0–59 months	678	HAZ	Water (Access and Source)	Intervention planning	To determine the prevalence and determinants of stunting	Time to water source was associated with stunting. (OR = 0.69; 95% CI: 0.48–1.01)

(*Continued*)

Table 1. (*Continued*)

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance	Aim	Results
[86]	SSA	Meta-analysis	0–59 months	Not available	HAZ; WAZ	Water (Type); Sanitation (Type)	Policy;	To explore trends in mild, moderate, and severe stunting and underweight	Children's growth was associated with infection and suboptimal nutrition. Hence, food insufficiency, poor water and sanitation, and restricted access to high-quality primary care, all associated with household and community poverty and were associated with poor growth outcomes
[67]	SSA	DHS	0–59 months	Not available	HAZ; WAZ	Water (Source); Sanitation (Access)	Policy	To report on socio-economic inequality in childhood malnutrition and to provide evidence for an association between socio-economic inequality and the average level of malnutrition	An indicator of socio-economic status, including clean water and a toilet, was developed using principal component analysis. After correcting for the concentration index's dependence on mean malnutrition the median concentration index for SSA was −0.15, where negative values imply that malnutrition is more concentrated among poorer children. There was thus a marginal association between average stunting and socio-economic inequality
[72]	Ghana	DHS	0–59 months	3061	HAZ	Water (Access); Sanitation (Access)	Policy; Intervention planning	To summarise inequality in children's height-for-age z-scores across the entire socio-economic distribution and decompose this inequality into different contributing factors	Access to sanitation in terms of having a toilet and access to safe water was not associated with malnutrition
[57]	SSA	DHS	0–6 months	Not available	Stunting	Water (Access)	Policy	Examine the independent association of six different types of food (exclusive breastfeeding, non-exclusive breastfeeding, infant formula, milk liquids, non-milk liquids and solid foods) with five measures of infant health (length, weight, diarrhoea, fever and cough)	Study shows that for an infant younger than 6 months old following current guidelines and exclusively breastfeeding instead of giving the infant solid foods was associated with higher length by 0.75 cm and weight by 0.25 kg and lesser diarrhoea, fever and cough prevalence by 8, 12 and 11%, respectively. Authors were unable to control for access to sanitary water: a necessary ingredient in infant formula without which the results could be biased upwards

Table 2. Review articles included in systematic review

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance		Results
[35]	SSA	Review	0–59 months	Not available	HAZ; WAZ; WHZ	Water (Source and Type); Sanitation (Type); Hygiene (Hand Washing)	Policy; Intervention planning	To assess nutrition-specific interventions across the life cycle for evidence of benefit	WASH interventions with significant effects: reduced risk of diarrhoea with hand washing with soap (RR 0.52, 95% CI 0.34–0.65), with improved water quality, and with excreta disposal Open defecation explained 54% of international variation in child height by contrast with GDP, which only explained 29%. A 20% point reduction in open defecation was associated with a 0.1 SD increase in child height
[7]	SSA	Review	0–59 months	Not available	HAZ; WAZ; WHZ	Water (Access); Sanitation (Access)	Policy; Intervention planning	To review maternal and child undernutrition and overweight in low-income and middle-income countries	Studies have consistently shown that diarrhoea is the most important infectious disease determinant of stunting. A framework for actions to achieve optimum child nutrition and development require nutrition-sensitive programmes and approaches including water and sanitation is proposed
[81]	South Africa	Review	0–59 months	Not available	Stunting	Water (Source); Sanitation (Access); Hygiene (Food and Domestic Hygiene)	Policy	To profile the current food hygiene and safety needs of children under the age of 5 in South Africa. To reflect the importance of domestic hygiene, access to water and sanitation in reducing the transmission of gastrointestinal pathogens while feeding infants and young children. To highlight the need for collaboration between healthcare professionals and the local authorities who provide basic services	Two studies reported that water source and sanitation were correlated with linear growth in children. In addition, latrine ownership was associated with lesser risk of stunting
[61]	SSA	Review	0–59 months	Not available	Stunting	Water (Source and Type); Sanitation (Access and Type); Hygiene (Hand Washing and Food Hygiene)	Policy; Intervention planning	To review the evidence linking WSH measures to faecal-oral diseases in children	While the relationship between diarrhoeal disease and malnutrition is complex, reviewing the evidence linking WASH measures to faecal-oral diseases in children suggests stunting in children aged 24 months was associated with five or more diarrhoeal episodes experienced in the first 2 years of life
[68]	SSA	Review	0–59 months	Not available	HAZ; WAZ; WHZ	Water (Source); Sanitation (Access and Type); Hygiene (Non-specific)	Intervention planning	To provide a narrative review of the current understanding of EED: epidemiology, pathogenesis, therapies and relevance to child health	EED is established during infancy and was associated with poor sanitation, certain gut infections and micronutrient deficiencies

(*Continued*)

Table 2. (*Continued*)

Ref #	Country	Design	Age	Sample	Nutritional status	WASH	Governance		Results
[11]	SSA	Review	0–24 months	Not available	HAZ	Water (Source and Type); Sanitation (Type); Hygiene (Hand Washing)	Policy; Intervention planning	This review article considers two broad questions: (1) can WASH interventions make a significant contribution to reducing the global prevalence of childhood stunting, and (2) how can WASH interventions be delivered to optimise their effect on stunting and accelerate progress?	The evidence reviewed suggests that poor WASH conditions have a significant detrimental effect on child growth and development resulting from sustained exposure to enteric pathogens
[48]	SSA	Review	0–59 months	Not available	HAZ	Water (Source); Sanitation (Access); Hygiene (Non-specific)	Policy	To assess the global trends in stunting	Action to reduce stunting requires improvements in WASH
[49]	SSA	Review	0–59 months	Not available	HAZ; WAZ	Water (Type); Sanitation (Type)	Intervention planning	This review documents the evidence that intestinal infections lead to malnutrition and that malnutrition worsens intestinal infections. Also reviewed are the mechanisms by which enteric infections lead to undernutrition and by which malnutrition worsens enteric infections, with implications for potential novel interventions	Authors suggest that a substantial proportion of global malnutrition is due to impaired intestinal absorptive function resulting from multiple and repeated enteric infections. The economic, human and societal impact of repeated and prolonged enteric infections is far greater than ever calculated. Thus, any effective interventions, ranging from targeted antimicrobial therapy and key micro- and macronutrient approaches to improved water and sanitation, have far greater cost-benefit effects than ever adequately appreciated
[60]	SSA	Review	0–59 months	Not available	HAZ	Water (Source)	Policy; Intervention planning	To summarise what we do and do not know about these very early alterations in intestinal digestive function, discuss their potential impact on childhood growth and examine the policy implications for interventions to interrupt this pathway to stunting	A number of factors have been proposed to underlie altered function of small bowel mucosa, including a combination of microbial contamination of water and food. In young infants and children, EED may precede and dispose to malnutrition of varying degrees, which in turn contributes to an increased incidence of infectious disease, especially diarrhoea
[85]	SSA	Review	0–59 months	Not available	Stunting; Wasting	Water (Type); Sanitation (Type); Hygiene (Food Hygiene)	Policy; Intervention planning	Aims to demonstrate that weaning foods prepared under unhygienic conditions are frequently heavily contaminated with pathogens and thus are a major factor in the cause of diarrhoeal diseases and associated malnutrition	Weaning foods prepared under unhygienic conditions are frequently heavily contaminated with pathogens and thus are a major factor in the cause of diarrhoeal diseases and associated malnutrition. To prevent foodborne diseases, a multidisciplinary approach is needed. Environmental conditions need to be improved, including the provision of safe water supplies and sanitation

[65]	SSA	Review	0–36 months	Not available	HAZ	Water (Source, Type and Treatment); Sanitation (Access and Type); Hygiene (Hand Washing and Domestic Hygiene)	Policy; Intervention planning	To review evidence on the links between clean water, sanitation and hygiene (WASH), and stunting and anaemia, which are known risk factors for child developmental deficits, and highlight how current WASH interventions fail to adequately protect children in the first 3 years of life	In order to address stunting and anaemia as key risk factors for early childhood development, this review leads the authors to conclude that baby WASH interventions require baby hand washing at key times and creation of a hygienic and protective play environment, in addition to hygienic infant feeding and household hand washing and sanitation interventions in order to interrupt key faecal-oral vectors while paying attention to animal and human faeces
[8]	South Africa	Review	0–72 months	Not available	HAZ	Water (Access and Type); Sanitation (Access and Type)	Policy	To investigate the changes in the prevalence of stunting	Stunting is highly correlated with poorer socio-economic status and environmental conditions, especially in rural provinces with poor access to water and sanitation
[88]	SSA	Review	0–59 months	Not available	HAZ; Underweight; Wasting	Water (Type); Sanitation (Access); Hygiene (Hand Washing)	Policy	To discuss the burden and trends of global under 5 years, infections and nutrition conditions; aetiology and associated risk factors; biological plausibility and the interrelation between infections, nutrition and growth; and existing interventions and strategies to reduce major childhood infections and improve nutrition and growth and implications	Infection-specific risk factors include poor water quality, unhygienic excreta disposal, unwashed hands and consequent undernutrition WASH strategies (hand washing with soap, improved water quality and excreta disposal) can reduce diarrhoea morbidity in children by 42%, 37% and 31%, respectively; however, a recent meta-analysis suggests a small benefit of WASH interventions on length growth in children <5 years of age
[89]	SSA	Review	0–59 months	Not available	HAZ	Water (Access); Sanitation (Access and Type); Hygiene (Non-specific)	Policy; Intervention planning	To review the existing literature regarding the underlying causes of and potential interventions for EED and poor growth in children, highlighting the epidemiology, clinical and histologic classification of the entity, as well as discussing novel biomarkers and possible therapies	Improving WASH, as well as the child's macro- and micro-nutrient intake, may be the primary means of preventing or mitigating environmental enteropathy and undernutrition

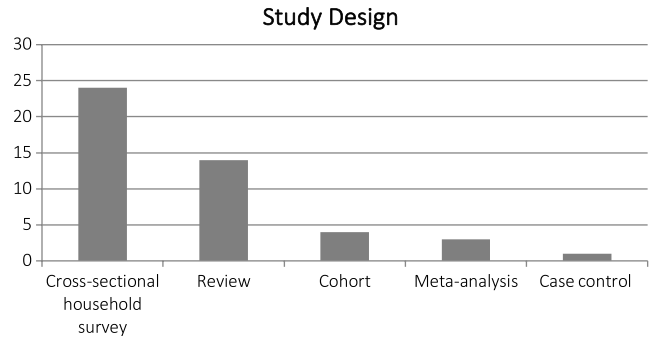

Fig 2. Study design.

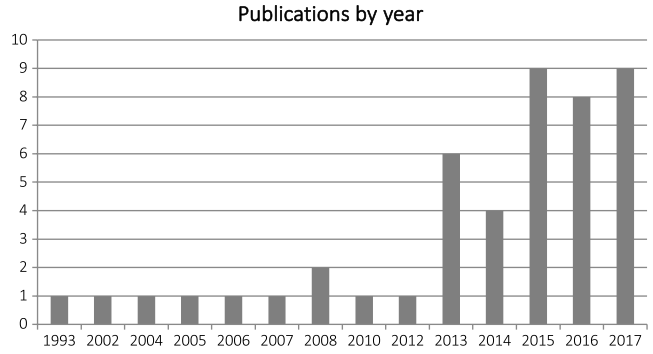

Fig. 3. Publications by year.

the observational studies, and access to sanitation, or type of sanitation infrastructure, as a significant risk factor in 15 of the studies.[51,53–56,58,62–64,73,75,77,79,84,86] Hygiene, considered here as multiple forms of hygiene, or hygiene as an integrated concept was reported as a significant risk factor in one study.[64] All significant risk factors are in the expected direction, that is, associations in the direction typically hypothesised, for example, improved wash conditions predict reduced stunting. No association between WASH and nutritional status was reported in four papers.[67,72,83,87] With regard to the observational studies assessing the association between WASH and child growth, in unadjusted models, that did not control for child, household, parent and community characteristics, household access to improved water and toilets was associated with reduced stunting risk. After adjusting for child, household, parent and community variables, access to improved water was associated with reduced stunting at 1 and 5 years of age (relative risk ratios from 0.55 to 0.57).[63] In adjusted models, those that controlled for child, household, parent and community characteristics, open defecation externalities were important for child height-for-age z-scores where people lived in close proximity to one another. One study found that a one log-unit increase in population density was associated with lesser height-for-age z-score by about 0.04 SD.[73]

In terms of the 14 review articles included, 3 papers[11,35,65] aimed at assessing WASH interventions, while 4[7,8,48,88] were concerned with assessing trends in nutritional status. A total of seven articles[49,60,61,68,81,85,89] aimed at reviewing evidence between environmental enteric dysfunction (EED) and nutritional status, with EED as a mediating factor between poor WASH conditions and nutritional status. Results of the reviews highlighted water either in terms of source, type of infrastructure or access was reported as a significant risk factor in 12[7,8,11,48,49,60,61,65,81,85,88,89] of the papers, while the importance of access to sanitation or type of sanitation infrastructure was emphasised in 13[7,8,11,35,48,49,61,65,68,81,85,88,89] articles and hygiene in 9[11,35,48,49,61,65,85,88,89] of the reviews.

Geographical coverage

Nineteen publications dealt with SSA as a region, while three articles dealt with more than one country in SSA.[54,55,79] Individually, Ethiopia had the most publications with six,[62,63,71,75,77,80] Tanzania[52,70,78] and Somalia[66,69,74] had three articles each, while Ghana[72,87] and South Africa[8,81] had two articles each, and Cameroon,[51] Gambia,[59] Nigeria,[50] Kenya,[58] Sierra Leone,[82] Uganda,[56] Zambia[84] and Zimbabwe[64] had one publication each (Fig. 4). An electronic survey of specific policies related to Water-only, Sanitation-only, and WASH and subsequent links to health and/or nutrition in individual SSA countries was also conducted (Table 3). Of the 49 countries surveyed, policies relating to water could not be found for 6 countries (Angola, Djibouti, Central African Republic, Equatorial Guinea, Gabon and Somalia). The authors could not access the specific water policy documents for 12 countries (Angola, Djibouti, Central African Republic, Comoros, Republic of Congo, Equatorial Guinea, Gabon, Gambia, Guinea-Bissau, Mauritius, Seychelles and Somalia). For nine countries (Central African Republic, Republic of Congo, Equatorial Guinea, Mauritius, Somalia, South Sudan, Swaziland, Tanzania and Zambia), no sanitation policy was found. The sanitation policy documents could not be accessed for 10 countries (Central African Republic, Republic of Congo, Equatorial Guinea, Seychelles, Somalia, South Sudan, Swaziland, Tanzania and Zambia). For four countries, there were no other policy documents reviewed that linked WASH and health/nutrition (Angola, Equatorial Guinea, Mauritius and Swaziland). No WASH policies were found.

In terms of the content of the policies, some 16 countries (Burkina Faso, Burundi, Eritrea, Ethiopia, Gambia, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Namibia, Nigeria, Sudan and Zimbabwe) made reference to hygiene in their respective policies. A total of four countries (Burundi, Mauritania, São Tomé and Príncipe, and Uganda) linked water and nutrition in general. A further two countries (Liberia and Zimbabwe) linked water and child health in general, while two countries (Rwanda and South Africa) linked water and nutritional status in children. Some 14 countries (Burundi, Cape Verde, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Gabon, Guinea-Bissau, Kenya, Niger, Rwanda, São Tomé and Príncipe, Senegal, and Togo) linked sanitation and nutrition in general. A total of six countries linked sanitation and child health in general, and three countries (Cameroon, Malawi and Uganda) made reference to the importance of the link between sanitation and nutritional status in children.

Nexus between WASH, undernutrition and governance

In terms of nutritional status, 44 articles considered stunting,[7,8,11,22,35,48–54,56–59,62–75,77–89] 17 articles underweight,[7,35,49,51,55,56,58,59,66–68,75,79,80,83,86,88] and 16 articles wasting.[7,35,54,56,58,59,62,68,69,74–76,79,80,82,88] A total of eight articles were concerned with water alone[52,57,60,66,69,74,76,78] while four articles dealt solely with sanitation.[54,56,62,75] A combination of water and sanitation was reported in 21 articles[7,8,49–51,53,55,58,67,70–73,77,79,80,82–84,86,87] and 13 articles reported

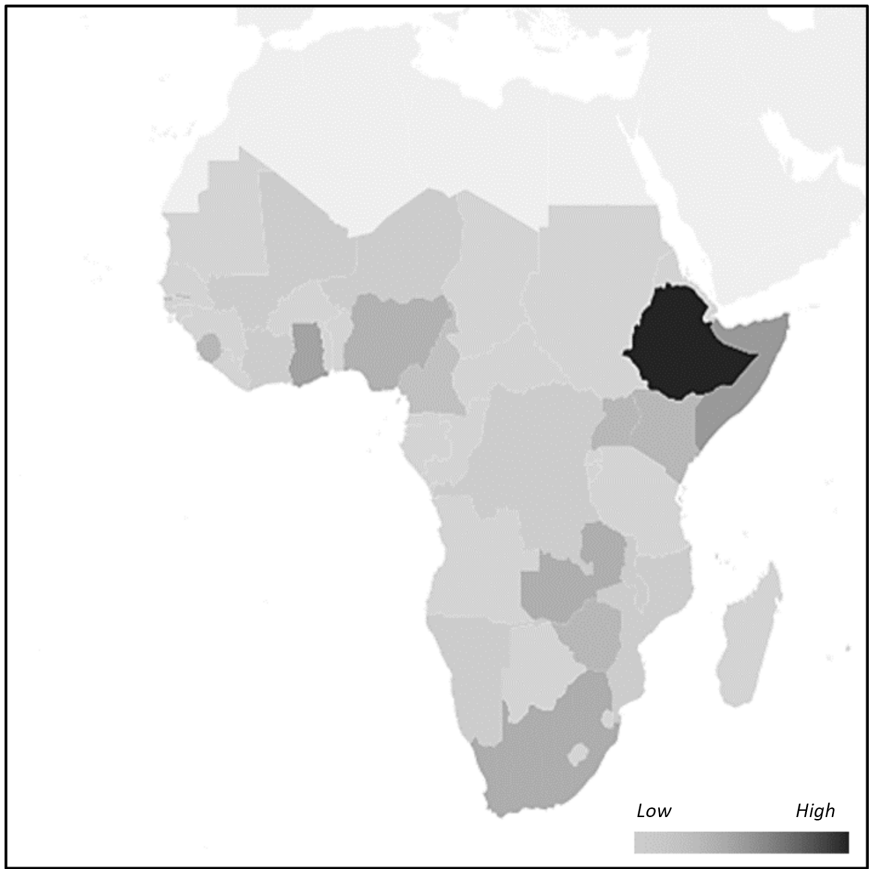

Fig. 4. Number of publications by country.

on WASH.[11,35,48,59,61,63–65,68,81,85,88,89] Twenty-one articles considered water source,[11,35,48,50,52,59–61,65–70,74,79–81,83,84,87] 11 were concerned with access to water,[7,8,57,58,63,72,76–78,82,89] 19 with type of infrastructure as defined by the JMP[11,35,50,51,53,55,61,63,64,70,73,79,80,84,86] and 2 with water treatment.[65,71] Twenty-one articles dealt with access to sanitation,[7,8,48,54,56,58,59,61,62,65,67,68,70,72,73,77,81–83,88,89] and 22 with type of sanitation.[8,11,35,49–51,53,55,61,63–65,68,75,79,80,82,84–87,89] A total of six articles were non-specific in so far as they considered multiple forms of hygiene or hygiene as an integrated concept,[48,59,63,64,68,89] while three considered food hygiene,[61,81,85] two domestic hygiene[65,81] and five hand washing.[11,35,61,65,88]

Fourteen articles made explicit reference to the sentiment that the results of the research conducted had policy implications,[8,48,56,57,66,67,71,73,76,80,81,83,86,88] while a total of 15 articles advocated for the importance of their results for the planning and development of interventions.[49,51,52,54,59,62,64,68–70,75,77–79,82] A total of 17 of the articles included noted the importance of their results for both policy and intervention planning.[7,11,35,50,53,55,58,60,61,63,65,72,74,84,85,87,89] None of the articles unfortunately elaborated on neither precise policies nor specific intervention mechanisms but rather remained non-descript in their reports.

Discussion

In the literature that was included in this review, only 46 articles were included and indicate a relatively limited body of knowledge on the nexus between governance, WASH and nutritional status in children in the sub-Saharan African context. Publications on this topic have however been increasing, suggesting that this is an emerging and growing field of interest. In conducting this systematic review, there were no scientific studies or evidence specifically focused on linking the governance of WASH and nutritional status in children. All included publications did note some policy implications based on study results; however, the precise manner in which this could or should be operationalised was rarely elaborated on.

In terms of the coverage of the literature for each of the individual WASH components, among the observational studies, more articles reported water as a significant risk factor than sanitation. Interestingly, among the reviews, more articles reported sanitation as a significant risk factor than water, with hygiene being the least represented component in both the observational studies as well as reviews. While some studies are concerned with water or sanitation separately, water and sanitation were reported most, followed by WASH. Water source was reported most often, followed by type of water infrastructure, access to water and finally water treatment. Access to sanitation was most reported followed by type of sanitation infrastructure. With regard to hygiene, being the least represented component, hand washing was reported most, followed by food and domestic hygiene, respectively.

In terms of geographic coverage, parts of the Horn, East Africa, along with Southern Africa and pockets of West Africa were represented. Governments are also making progress by having water and sanitation policies in place with reference to the importance of WASH have for the health and nutritional status of children. However, for many countries, much work needs to be done in the political sphere to bring new knowledge and evidence to the fore in order to keep policy mechanisms in tune with the requirements of the population. It is important to note that there are no

Table 3. SSA policies

Ref	Country	Water Policy	Link to Health/Nutrition	Sanitation Policy	Link to Health/Nutrition	Other WASH and Health/Nutrition Links
Angola National Sanitary Development Plan (2012)	Angola	N/A	N/A	Angola National Sanitary Development Plan (2012)	The PNDS has ambitious objectives in all areas of the National Health System, including strengthening the fight against priority diseases, which currently frame communicable diseases and chronic non-communicable diseases, mother and childcare, improved proximity to services	N/A
National Water Policy (2008); National Action Plan for the Integrated Management of Water Resources (2011); National Heath Policy (2009); National Sanitary Development Plan (2009)	Benin	National Water Policy (2008); National Action Plan for the Integrated Management of Water Resources (2011)	Ensuring the public health protection with impacts on both public health and the socio-economic development of the country	National Sanitary Development Plan (2009)	Recognising the prominent role of health research in decision-making. The nutritional situation of women of childbearing age and their children is also worrying as 9% of them are underweight and 61% are anaemic	National Health Policy (2009) Policy initiatives for provision of water and sanitation through the Ministry of Mines, Energy and Water; Ministry of Health
Botswana National Water Policy (2012); Botswana National Health Policy (2011)	Botswana	Botswana National Water Policy (2012)	Safe, affordable and reliable water and sanitation must be provided to all the people of Botswana to promote a healthy population	Botswana National Water Policy (2012)	Safe, affordable and reliable water and sanitation must be provided to all the people of Botswana to promote a healthy population	Botswana National Health Policy (2011). Policy initiatives for provision of water and sanitation through the Ministry of Minerals, Energy and Water Resources
Policy and Strategies on Water in Burkina Faso (1997); Governance Programme for the Water and Sanitation Sector (2016); National Sanitary Development Plan (2011); National Health Policy (2011)	Burkina Faso	Policy and Strategies on Water in Burkina Faso (1997). Governance Programme for the Water and Sanitation Sector Burkina Faso (2016)	The impact of structures and facilities on public health, design of sanitation and irrigation systems to reduce diseases as well as then to education in hygiene and health. Decentralised technical services (water, health, education) improve the synergy of their actions towards local authorities	Governance Programme for the Water and Sanitation Sector Burkina Faso (2016). National Sanitary Development Plan (2011)	Decentralised technical services (water, health, education) improve the synergy of their actions towards local authorities. The major diseases of public health importance are malnutrition, diarrheal diseases women and child health. The Burkinabe Government is convinced that health is at the heart of development and has made it one of the priority sectors. Substantial progress has been made in the social sectors, including health and drinking water	National Health Policy (2011). Policy initiatives for provision of water and sanitation through the Ministry of Health

National Water Policy (2009); National Sanitation Policy and Operational Strategy Horizon 2025 (2013); National Sanitary Development Plan (2005)	Burundi	National Water Policy (2009)	The contribution of water in the health sector is the improvement of the health of populations through the consumption of quality water, environmental sanitation and hygiene. The agricultural deficit is due, among other reasons, to non-control of water for food production. It results in a high malnutrition, a precarious health situation	National Sanitation Policy and Operational Strategy Horizon 2025 (2013). National Sanitary Development Plan (2005)	The lack of adequate sanitation constitutes a disaster that is both sanitary, ecological and economic: the impact on the natural environment and on human health amounts to thousands of sick people and deaths. This policy aims to improve the health status of the population through nutrition and food security as well as the development of an inter-sectoral partnership that could contribute to improvement of health indicators – access to drinking water and basic nutritional services	Policy initiatives for provision of water and sanitation through the Ministry of Water, Environment, Development of the Territory and Urbanism and Public Health Ministry
National Action Plan for the Integrated Management of Water Resources (PANGIRE) (2009); National Health Technology Policy (2009); Sectoral Health Strategy (2016); Water Solidarity Programme (2013)	Cameroon	National Action Plan for the Integrated Management of Water Resources (PANGIRE) (2009)	It concerns the vital needs of men, economic activities, the protection of the environment, planning and public health. Water for agriculture, livestock and food	National Health Technology Policy (2009); Sectoral Health Strategy (2016)	The improvement of health services for the entire population of Cameroon through universal access to healthcare and services, the promotion of healthy behaviours and the development of healthy living environments. The acquisition of health-enhancing skills in the following areas: food and nutrition, nutritional status of children under five nutritional status of adults including women of childbearing age	Water Solidarity Programme (2013). Policy initiatives for provision of water and sanitation through the Ministry of Water and Energy (MINEE) and Ministry of Public Health
New Water and Sanitation Code (2015); National Health Policy (2007); National Sanitary Development Plan (2008); National Basic Sanitation Plan (2010)	Cape Verde	New Water and Sanitation Code (2015)	The human right to drinking water and sanitation is closely related to the right to the highest attainable standard of physical and mental health	National Sanitary Development Plan (2008) National Basic Sanitation Plan (2010); New Water and Sanitation Code (2015)	Among other objectives, health sector reform aims to promote equity in access to healthcare. Strengthening interventions targeting malnutrition. Environmental sanitation actions should be seen as a basic public health measure	Policy initiatives for provision of water and sanitation through the Ministry of health and National Water and Sanitation Agency National Health Policy (2007)

(*Continued*)

Table 3. (*Continued*)

Ref	Country	Water Policy	Link to Health/Nutrition	Sanitation Policy	Link to Health/Nutrition	Other WASH and Health/Nutrition Links
Strategic plan to Strengthen Health Systems in CAR (2007); Health sector transition plan in Central African Republic (2015); National Health Development Plan (2017)	Central African Republic	N/A	N/A	N/A	N/A	Strategic plan to Strengthen Health Systems in CAR (2007); Health sector Transition Plan in Central African Republic (2015); National Health Development Plan (2017) The Central African Republic has developed and implemented several strategic documents related to the health sector with a view to improving the health of the people at the grassroots level. Improving the nutritional status of children. Schools and health centres lack sanitary facilities
The Master Plan for Water and Sanitation in Chad (2003); National health Policy (2006); National Sanitary Development Plan (2013); National Strategy for Universal Health Coverage of Chad (2015)	Chad	The Master Plan for Water and Sanitation in Chad (2003)	Water impacts on the sustainable improvement of population health	National Sanitary Development Plan (2013)	The national social protection strategy, in which the health component has been translated into a national strategy for universal sanitation coverage. In the field of malnutrition, there is still much to be done	Policy initiatives for provision of water and sanitation through the Ministry of Water and Sanitation and Ministry of Public Health National health Policy (2006). National Strategy for Universal Health Coverage of Chad (2015)
National Water Policy (N/D); Water Code (N/D); National Sanitary Development Plan (2010); National Health Policy (2005)	Comoros	National Water Policy (N/D). Water Code (N/D)	N/A	National Sanitary Development Plan (2010)	Protein-energy malnutrition is one of the national health concerns. Development of health services taking charge of health, nutrition	Policy initiatives for provision of water and sanitation through the Ministry of Production of the Environment, Energy, Industry and Crafts, Ministry of Health. National Health Policy (2005)
Law No. 15/026 concerning water (2015); Sanitary Development Plan (2016); Strategy for strengthening the health system (2006)	Democratic Republic of the Congo	Law No. 15/026 concerning water (2015)	Dealing with the health needs of the public health safety	Sanitary Development Plan (2016)	Contribute to the improvement of the state of health. Nutritional status: undernutrition is the most common type of malnutrition in the DRC	Policy initiatives for provision of water and sanitation through the Ministry of Public Health. Strategy for strengthening the health system (2006)
Water Code (2003)	Republic of the Congo	Water Code (2003)	N/A	N/A	N/A	Policy initiatives for provision of water and sanitation through the Ministry of Energy and Hydraulics; Ministry of Health and Population
Sectoral Policy for Drinking Water in Ivory Coast (2016); National Sanitary Development Plan (2016)	Ivory Coast	Sectoral Policy for Drinking Water in Ivory Coast (2016)	The overall objective of the programme is to contribute to the reduction of poverty and the improvement of population health	National Sanitary Development Plan (2016)	The overall objective of the programme is to contribute to the reduction of poverty and the improvement of population health. The Government of Côte d'Ivoire has made nutrition one of its priorities	Policy initiatives for provision of water and sanitation through the Ministry of Economic Infrastructure; Ministry of Health and Public Hygiene

Sanitary Waste Management Plan (2003); Sanitary Code (2007); National Sanitary Development Plan (2013)	Djibouti	N/A	N/A	Sanitary Waste Management Plan (2003); Sanitary Code (2007); National Sanitary Development Plan (2013)	Promotion of nutritional activities. The development of primary healthcare, health for all. A strong commitment to the fight against malnutrition	Policy initiatives for provision of water and sanitation through the Ministry of Health
	Equatorial Guinea	N/A	N/A	N/A	N/A	N/A
Ministry of Land, Water and Environment (Water Resources Department); Ministry of Health (Nutrition Unit); Eritrean Policy on Infant and Young Child Feeding (2013)	Eritrea	Action Plan for Integrated Water Resource Management (IWRM) in Eritrea (2008)	To improve the health and living condition of rural communities by achieving safe and sustainable sanitation and hygiene practices in relation to water supply and use	Action Plan for Integrated Water Resource Management (IWRM) in Eritrea (2008)	To improve the health and living condition of rural communities by achieving safe and sustainable sanitation and hygiene practices in relation to water supply and use	Eritrean Policy on Infant and Young Child Feeding (2013). Recommendations around food hygiene, hand washing and treatment of drinking water
Ethiopian Water Resource Management Policy (N/D); Ethiopian National Hygiene and Sanitation Strategy (2005)	Ethiopia	Ethiopian Water Resource Management Policy (N/D)	Provision of adequate reliable and clean water supply and sanitation services	Ethiopian National Hygiene and Sanitation Strategy (2005)	To complement the existing Health Policy and national water sector strategy while placing greater emphasis on 'on-site' hygiene and sanitation	Ethiopian National Hygiene and Sanitation Strategy (2005). Inter-sectoral collaboration delivered by health, water, education, rural development and agriculture offices
National Sanitary Development Plan (2011)	Gabon	N/A	N/A	National Sanitary Development Plan (2011)	Bring together the public health priorities accepted by all. Training/retraining health workers in the management of malnutrition cases. Developing cooperation between the Directorate General of Hydraulic Resources and the Ministry of Health	In 2018, Gabon plans to adopt a code of water and sanitation. Policy initiatives for provision of water and sanitation through the Ministry of Energy and Hydraulic Resources; Ministry of Health, Social Affairs, Solidarity and Family
Gambia National Water Policy (N/D); The Gambia National Strategy for Sanitation and Hygiene (2011)	Gambia	Gambia National Water Policy (N/D)	N/A	The Gambia National Strategy for Sanitation and Hygiene (2011)	Reduction in the frequency of environmental health and safety-related problems and diseases	Gambia National Nutrition Policy (2010). Support campaigns on environmental sanitation, including access to safe water supplies, personal hygiene, food hygiene and safety
National Water Policy (2007); Environmental Sanitation Policy (2010); National Nutrition Policy (2013)	Ghana	National Water Policy (2007)	Improving access to potable water and sanitation is critical to achieving favourable health outcomes, which in turn facilitates economic growth and sustained poverty reduction	Environmental Sanitation Policy (2010)	Improved environmental sanitation has direct effects on healthcare waste management, vector and waterborne diseases that affect millions of children and women	Through National Nutrition Policy (2013). The suboptimal water and sanitation situation in Ghana is a key underlying determinant of health and nutritional status

(*Continued*)

Table 3. (*Continued*)

Ref	Country	Water Policy	Link to Health/Nutrition	Sanitation Policy	Link to Health/Nutrition	Other WASH and Health/Nutrition Links
Water Code (1994); National Declaration of Commitments of the Republic of Guinea: Water Sector and Sanitation Sector (N/D); National Health Policy (2014)	Guinea	Water Code (1994). National Declaration of Commitments of the Republic of Guinea: Water Sector and Sanitation Sector (N/D)	Health protection, pollution control and the preservation of the environment. Quantities of water needed for human nutrition, hygiene care. Improving the health status of populations. Impact on health and on the economy	National Declaration of Commitments of the Republic of Guinea: Water Sector and Sanitation Sector (N/D)	Impact on health and on the economy. Strengthening the national health system, scaling up of high-impact activities – vaccination, nutrition. Essential objectives that contribute to improving health. Protection of food and nutritional conditions	Policy initiatives for provision of water and sanitation through the Ministry of Water and Electricity; Health Ministry. National Health Policy (2014). Public Health Code (N/D)
Water Code (1992); Master Plan for Water Supply and Sanitation (1991); Sanitary Development Plan (2008)	Guinea-Bissau	Water Code (1992). Master Plan for Water Supply and Sanitation (1991)	N/A	National Sanitary Development Plan (2008)	Improving access to health services, equitable distribution of resources. Malnutrition is the first public health problem among non-communicable diseases	Policy initiatives for provision of water and sanitation through the Ministry of Public Health
The National Water Services Strategy (2007); Kenya Environmental Hygiene and Sanitation Policy (2016); National Food and Nutrition Security Policy (2011)	Kenya	The National Water Services Strategy (2007)	Assured water supply, sewerage services and basic sanitation for all Kenyans for improved health and wealth creation on an individual level and for the nation	Kenya Environmental Hygiene and Sanitation Policy (2016)	Ensure strong leadership and coordination at all levels to build and sustain governance for sanitation and hygiene across sectors especially water, health, nutrition, education, gender and the environment	National Food and Nutrition Security Policy (2011). Uptake of critical nutrition and health interventions focusing on child care practices, dietary choices, improved hygiene, water and sanitation are essential to address all forms of malnutrition
Lesotho Water and Sanitation Policy (2007); Health Sector Strategic Plan (2013)	Lesotho	Lesotho Water and Sanitation Policy (2007)	Develop and implement programmes aimed at creating public awareness on linkages between water supply, sanitation, health and hygiene	Lesotho Water and Sanitation Policy (2007)	Develop and implement programmes aimed at creating public awareness on linkages between water supply, sanitation, health and hygiene	Health Sector Strategic Plan (2013). Sanitation and hygiene are among the priorities of the health sector. Arrived at by examining contributions to the heaviest burden of disease
Water Supply and Sanitation Policy (2009); Nutrition Policy (2008)	Liberia	Water Supply and Sanitation Policy (2009)	Safe water, hygiene practices and sanitation are directly linked to improved public health, especially for vulnerable groups such as children	Water Supply and Sanitation Policy (2009)	Safe water, hygiene practices and sanitation are directly linked to improved public health, especially for vulnerable groups such as children	National Nutrition Policy (2008). To improve nutrition case management of childhood diseases and to improve access to quality health services, safe water, environmental sanitation and waste disposal systems
Water code (1999); Sectoral Policy Declaration for Water (2009); National Strategy for Water, Sanitation and Hygiene (2013); Policy and National Strategy for Sanitation (N/D). Health Sector Development Plan (2015)	Madagascar	Water code (1999). Sectoral Policy Declaration of water (2009). National Strategy for Water, Sanitation and Hygiene (2013)	The protection of water resources is integral to health and security. It is a necessary condition for poverty eradication, women's empowerment and health protection	National Strategy for Water, Sanitation and Hygiene (2013). Policy and National Strategy for Sanitation (N/D)	Integral to health and security. It is a necessary condition for poverty eradication, women's empowerment and health protection	Policy initiatives for provision of water and sanitation through the Water Ministry; Ministry of Energy and Mines; Ministry of Public Health. Health Sector Development Plan (2015)

National Water Policy (2007); National Sanitation Policy (2006); Infant and Young Child Nutrition Policy and Guidelines (2003); Food and Nutrition Security Policy (2005)	Malawi	National Water Policy (2007)	Improving public health through integration of rural water supply and Participatory Hygiene and Sanitation Transformation	National Sanitation Policy (2006)	Seeks to increase access to clean water and sanitation, improve the nutritional status of children and ensure food security	Infant and Young Child Nutrition Policy and Guidelines (2003). Caregivers should be advised to always follow the standard food hygiene rules when preparing food for the child to avoid food contamination. Food and Nutrition Security Policy (2005). Provision of safe water and adequate sanitation, and hygiene to prevent diseases
National Water Policy (2006); National Water Policy and Code (2012); National Sanitation Policy (2009); Decennial Plan of Development and Health (2014)	Mali	National Water Policy (2006). National Water Policy and Code (2012)	Focus on sanitation, education for health and hygiene. Promote access to basic health, nutrition, clean water and sanitation	National Sanitation Policy (2009)	Broader vision of sanitation, which is then to make a healthier environment, not dangerous for human health and its environment	Policy initiatives for provision of water and sanitation through the Ministry of the Environment and Sanitation; Ministry of Health and Public Hygiene. Decennial Plan of Development and Health (2014)
Water Code (2005); Strategy for Development of the Water and Sanitation Sector (2012); National Health and Social Action Policy (2006); National Health Policy (2017)	Mauritania	Water Code (2005)	Ensure the supply of drinking water and ensure the protection of water intended for human nutrition decentralised health services for the promotion of autonomous sanitation and hygiene	Strategy for Development of the Water and Sanitation Sector (2012)	The taking into charge by the State, municipalities and investment associations of collective sanitation in public buildings (schools, health centres and others)	National Integrated Project of the Water Sector in Rural Areas (PNISER) – African Development Bank. Policy initiatives for provision of water and sanitation through the Ministry of Hydraulics; Ministry of Health. National Health and Social Action Policy (2006). National Health Policy (2017)
Water Management Policy (2013)	Mauritius	Water Management Policy (2013)	N/A	N/A	N/A	N/A
Water Law n.16/91 (1991); Water Policy (2007); National Strategy for Water and Urban Sanitation (2011); Health Sector Strategic Plan(2013)	Mozambique	Water Law n.16/91 (19991). Water Policy (2007). National Strategy for Water and Urban Sanitation (2011)	The purpose of sanitation of population centres is to ensure conditions compatible with the requirements of public health. To ensure maximum positive benefit for consumers and to avoid potential public health risks. Improving food security. It is urgent to introduce systematic measures to improve sanitation in order to safeguard the health and dignity of the population	National Strategy for Water and Urban Sanitation (2011)	It is urgent to introduce systematic measures to improve sanitation in order to safeguard the health and dignity of the population. Leading to a single result: improving the health status of the population	Policy initiatives for provision of water and sanitation through the Ministry of Construction and Water; Ministry of Public Works and Housing; Ministry of Health. Health Sector Strategic Plan (2013)
Water Supply and Sanitation Policy (2008); National Policy on Infant and Young Child Feeding (2003)	Namibia	Water Supply and Sanitation Policy (2008)	The development of adequate extension services for water supply and sanitation, covering the entire range from community management skills through technical training to health and hygiene education, is necessary for the revised WSS sector policy to succeed	Water Supply and Sanitation Policy (2008)	The development of adequate extension services for water supply and sanitation, covering the entire range from community management skills through technical training to health and hygiene education, is necessary for the revised WSS sector policy to succeed	National Policy on Infant and Young Child Feeding (2003). Wash hands before preparation. Use clean utensils washed in soap and water and boiled and kept covered. Boil water for 5 min and cool to room temperature before mixing

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Table 3. (*Continued*)

Ref	Country	Water Policy	Link to Health/Nutrition	Sanitation Policy	Link to Health/Nutrition	Other WASH and Health/Nutrition Links
National Water and Sanitation Policy (N/D); National Sanitary Development Plan (2011); Strategic Plan of National System of Health Information (2012)	Niger	National Water and Sanitation Policy (N/D)	Following fundamental objectives: food security, protect the environment and health	National Water and Sanitation Policy (N/D) National Sanitary Development Plan (2011)	Following fundamental objectives: food security, protect the environment and health. Revitalisation of primary healthcare and halve malnutrition by 2015	Policy initiatives for provision of water and sanitation through the Ministry of Hydraulics and Sanitation of Niger; Ministry on Public Health. National System of Health Information (2012)
National Water Policy (2004); National Water Sanitation Policy (2004); National Policy on Food and Nutrition in Nigeria (2001); National Policy on Infant and Young Child Feeding in Nigeria (2010)	Nigeria	National Water Policy (2004)	The importance of eradicating poverty and therefore to enhance an improvement in public health through an optimal use of water resources for development remains the main driving force for the Government of Nigeria	National Water Sanitation Policy (2004)	Sanitation development is essentially multi-sectoral. An integrated approach combining safe sanitation, hygiene education and promotion and safe water supply ensures improved health and livelihood	National Policy on Food and Nutrition in Nigeria (2001). Malnutrition results from a combination of inadequate food intake, lack of access to clean water, and health and sanitation problems. National Policy on Infant and Young Child Feeding in Nigeria (2010). Combat disease and malnutrition, including within the framework of primary healthcare, through, the provision of adequate nutritious foods and clean drinking water
National Water Supply Policy (2016); National Sanitation Policy (2016); National Food and Nutrition Policy (2013); National Nutrition Policy (2007)	Rwanda	National Water Supply Policy (2016)	Poor water supply and sanitary conditions due to the lack of adequate water supply promote diarrhoea, intestinal parasites and environmental enteropathy, and have complex and reciprocal links to malnutrition in children	National Sanitation Policy (2016)	The health cross-sector collaboration has to be strengthened to tackle multi-factorial determinants affecting the health of the population (poverty reduction, nutrition and food security, water and sanitation	National Food and Nutrition Policy (2013). Problems of water, hygiene and sanitation affect the synergy between malnutrition and infection. High priority for hygiene is justified because improved personal and domestic hygiene practices can reduce diarrhoea. National Nutrition Policy (2007). Scaling up of community-based nutrition programmes requires social mobilisation activities for the promotion of safe water, personal and environmental hygiene
Participatory Strategy for Water and Sanitation of São Tomé and Príncipe (2012)	São Tomé and Príncipe	Participatory Strategy for Water and Sanitation of São Tomé and Príncipe (2012)	Recognising that the water and sanitation sector are two important axes for the development of the country, since they contribute positively to the improvement of health and contribute to poverty reduction, in particular in reducing malnutrition	Participatory Strategy for Water and Sanitation of São Tomé and Príncipe (2012)	Recognising that the water and sanitation sector are two important axes for the development of the country, since they contribute positively to the improvement of health and contribute to poverty reduction, in particular in reducing malnutrition	Policy initiatives for provision of water and sanitation through the Ministry of Public Works and Natural Resources
Integrated Management Action Plan for Water Resources in Senegal (2007); Sanitation Code (2009); National Plan of Health Development (2009); National Policy of Community Health (2014)	Senegal	Integrated Management Action Plan for Water Resources in Senegal (2007)	The issue of water is a national issue given its impact on different sectors of development of the country: health, industry	Sanitation Code (2009). National Plan of Health Development (2009)	Prevent damage to health. Health policy remains based on primary healthcare. Developing nutrition policy	Policy initiatives for provision of water and sanitation through the Ministry of Urbanism, Habitat, Urban Hydraulics, Public Health e Sanitation; National Plan of Health Development (2009). National Policy of Community Health (2014)

National Water Policy (2017); Comprehensive and Integrated Sanitation Master Plan (2014); National Health Policy (2016)	Seychelles	National Water Policy (2017)	N/A	Comprehensive and Integrated Sanitation Master Plan (2014)	N/A	National Health Policy (2016). The Constitution of Seychelles ensures free primary healthcare and universal access to safe drinking water, good sanitation and housing provision
National Water and Sanitation Policy (2010); Sierra Leone National Food and Nutrition Security Policy (2012)	Sierra Leone	National Water and Sanitation Policy (2010)	The Ministry of Health and Sanitation is responsible for public health and sanitation in the country. By its mandate, it is responsible for conducting health studies and reporting incidences of waterborne communicable diseases; water quality testing; and investigating sources of water pollution	National Water and Sanitation Policy (2010)	The main objective is to improve the health of communities and ensure that the majority of the population has access to sanitation services	Sierra Leone National Food and Nutrition Security Policy (2012). Factors including access to reliable health services and living in sanitary environments with access to potable water are necessary for proper food utilisation
IYCF Strategy and Action Plan Somalia (2017)	Somalia	N/A	N/A	N/A	N/A	IYCF Strategy and Action Plan Somalia (2017). Poor water, hygiene and sanitation practices are common in Somalia and are a key contributor to malnutrition. There is low access to safe water or to sanitation facilities. Hygiene practices such as hand washing at key times with soap or ash are uncommon
National Water Policy for South Africa (1997); National Sanitation Policy (2016); Infant and Young Child Feeding Policy (2008); National Policy on Food and Nutrition Security (2014)	South Africa	National Water Policy for South Africa (1997)	The Right of access to sufficient water promises every child the right to, among other things, basic nutrition and healthcare services	National Sanitation Policy (2016)	The public health benefits of improved sanitation are maximised when sanitation is planned and provided in an integrated manner with other basic services	Infant and Young Child Feeding Policy (2008). Ingestion of contaminated water, fluids and food may lead to gut mucosal damage and disruption of immune barriers. National Policy on Food and Nutrition Security (2014). Tackling the problems of poverty, inequality and unemployment. It is a roadmap to a South Africa where all will have water, electricity, sanitation, jobs, housing, public transport and adequate nutrition
Water Policy (2007); Health Sector Development Plan (2012)	South Sudan	Water Policy (2007)	The provision of safe drinking water, basic sanitation and clean environment at household level can have a major impact on health	N/A	N/A	Health Sector Development Plan (2012). The widespread water contamination due to poor sanitation as a result of inappropriate solid and liquid waste disposal systems12 is a major risk factor for diseases
Water Supply and Environmental Sanitation Policy (2010); National Nutrition Policy (2009)	Sudan	Water Supply and Environmental Sanitation Policy (2010)	The overall goal of the water supply and environmental sanitation policy is to contribute in improving the health status and living conditions of the population and the economic growth of the nation by providing all of the population with adequate and sustainable access to WASH basic services and hygienic practices	Water Supply and Environmental Sanitation Policy (2010)	The overall goal of the water supply and environmental sanitation policy is to contribute in improving the health status and living conditions of the population and the economic growth of the nation by providing all of the population with adequate and sustainable access to WASH basic services and hygienic practices	National Nutrition Policy (2009). Nutrition is not adequately mainstreamed into either pre-service or in-service training for wider public health staff, nor for staff in related sectors such as education, water and sanitation and agriculture. As a result, the ability to work together across sectors is limited

(*Continued*)

Table 3. (*Continued*)

Ref	Country	Water Policy	Link to Health/Nutrition	Sanitation Policy	Link to Health/Nutrition	Other WASH and Health/Nutrition Links
National Water Policy (2009)	Swaziland (Eswatini)	National Water Policy (2009)	Swaziland has a social, moral and economic responsibility to ensure that all its citizens have adequate access to safe water and adequate sanitation to guarantee human dignity and health	N/A	N/A	N/A
National Water Policy (2002); National Nutrition and Social Behaviour Change Communication Strategy (2013)	Tanzania	National Water Policy (2002)	Safe drinking water and good sanitation practices are basic considerations for human health. Use of contaminated sources pose health risks to the population as evidenced by the incidences of waterborne diseases	N/A	N/A	National Nutrition and Social Behaviour Change Communication Strategy (2013). Higher priorities for behaviour change in relation to provision of food, and attention to critical actions in the area of water and sanitation and hand washing
National Policy for the Supply of Drinking Water and Sanitation in Rural and Semi-Urban Areas (2006); National Action Plan for the Water and Sanitation Sector (N/D); National Action Plan for Integrated Water Resources Management (N/D); National Health Policy (N/D); National Plan of Sanitary Development (N/D)	Togo	National Policy for the Supply of Drinking Water and Sanitation in Rural and Semi-Urban Areas (2006). National Action Plan for the Water and Sanitation Sector (N/D)	Improving the health of users is one of the objectives of this policy. Very significant potential impact in terms of improving public health	National Action Plan for the Water and Sanitation Sector (N/D); National Plan of Sanitary Development (N/D)	Strengthening the fight against malnutrition and micronutrient deficiencies. Very significant potential impact in terms of improving public health. Based on the vision of a Togo where the highest level of health is ensured to the population	Policy initiatives for provision of water and sanitation through the Ministry of Mines, Energy and Water; Ministry of Water, Sanitation and Rural Hydraulics; Ministry of Health and Social Protection
National Water Policy (1999); National Sanitation Policy (1997); Uganda Food and Nutrition Policy (2003); Policy Guidelines on IYCF (2009)	Uganda	National Water Policy (1999)	Promotion of public health and nutrition through reducing public health risks in irrigation and livestock water supply systems and increasing nutritional levels	National Sanitation Policy (1997)	The high incidence of diarrhoea has remained a leading cause of nutritional stunting. The goal of this policy is to promote and preserve the health of the community through improved sanitation. Attaining and maintaining a good standard of sanitation will greatly contribute to reducing mortality and morbidity from sanitation-related diseases as well as improving the socio-economic status of the community	Uganda Food and Nutrition Policy (2003). Promote the use of safe drinking water and sanitary means of waste disposal. Policy Guidelines on IYCF (2009). Encourage parents to practice high standards of hygiene when handling the infant's food and also to maintain sanitation standards and food/water safety

National Water Policy (2010); National Food and Nutrition Policy (2006)	Zambia	National Water Policy (2010)	The benefits from supply of sufficient quantities and good quality water and sanitation are important for the sustenance of health	N/A	N/A	National Food and Nutrition Policy (2006). Poor access to adequate quantity and quality of domestic water and poor sanitary conditions contributes to outbreaks of waterborne and other diarrhoeal diseases. These are closely associated with malnutrition
National Water Policy (2012); National Sanitation and Hygiene Policy (2017); National Nutrition Strategy (2014)	Zimbabwe	National Water Policy (2012)	The Ministry of Health and Child Welfare (MHCW) is a key player in the Rural WASH subsector responsible for water quality monitoring, promoting safe water supply and household sanitation. MHCW is responsible for promoting improvements in domestic hygiene, specifically through adoption of safe self-supply drinking water systems, and household investments in improving excreta disposal and safe sanitation	National Sanitation and Hygiene Policy (2017)	The Ministry responsible for health will be tasked with sanitation and hygiene subsector leadership on policy and standards. Poor access to sanitation and hygiene increases the disease burden leading to loss of productive time and increasing health costs	National Nutrition Strategy (2014). Government is committed to ensuring nutrition security for all through the implementation of evidence-based nutrition interventions that are integrated within a broad public health framework including health services, water and sanitation

specific health or nutrition outcomes that policies are evaluated against, especially not when it comes to children, and that each component of the WASH triad also have their own unique intricacies.

The link between WASH and nutrition is not one that should come as a surprise. WASH has long been part of the UNICEF conceptual framework, which provides a lens through which maternal and child undernutrition can be examined. This is achieved through providing a scalar model that incorporates immediate causes such as disease and dietary intake, underlying causes including household environment, food security and health services, as well as basic causes, referring to socio-economic and political context.[31]

Advocating for multi- and inter-sectoral approaches are therefore not new.[31,35,47,90,91] Fundamental to these kinds of grand challenges is the integration of various actors and the effective governance of resources and services as a precondition for the effectiveness and sustainability of WASH programmes and services.[29] Overwhelmingly, it seems that governments are committed, at least in principle and in policy, to linking WASH to health and/or nutritional outcomes (Table 3).

When it comes to dealing with the nexus between governance, WASH and nutritional status in children in SSA, scalability and sustainability depend on good governance and technical factors such as infrastructure and improved knowledge, and the availability of financial resources. However, while actors and stakeholders at various levels in the policy and governance arena advocate for multi- and inter-sectoral approaches, most nutritional status indicators show disappointing results. In 2013, for example, global estimates put the number of stunted children in LMIC at 161 million.[48] African prevalence's have stagnated since 1990 at about 40% and current trends suggest little improvement with business as usual.[1] Countries in SSA continue to make headway in terms of increased access to WASH services, financial resources however remain a critical issue.[92] Current levels of WASH financing are not sufficient to fund the achievement of SDG 6, estimated to cost an approximate $122 Billion between 2016 and 2030.[18,92] Important gaps in financing still exist with SSA countries, on average, committing 0.52% GDP to WASH expenditure. When excluding South Africa, this figure drops to a mere 0.27% GDP. Aid commitments for WASH to SSA have also declined from US$ 3.8 billion to US$ 1.7 billion from 2012 to 2015.[92]

Governance issues therefore include limited managerial capacity, poor financial resource administration, corruption and weak institutions, which all limit the capacity of the national sector to deliver sustainable results at scale.[93] No blueprints for WASH governance exist and no easy answers can be found on what constitutes the best governance model. Every country has its own set of governance systems, stakeholder dynamics and institutional structures, and therefore faces different problems and priorities.[29] The primary responsibility for service delivery of water and sanitation, as both a basic service and a human right, lies with the State; however, even if the State holds ultimate responsibility, a number of stakeholders take part in the implementation. The Commission on Global Governance defines governance as follows: 'the sum of many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting and or diverse interests may be accommodated and cooperative action may be taken. It includes formal [...] as well as informal arrangements that people and institutions have agreed to or perceive to be in their interest'.[94] Importantly is the distinction that governance is not exclusively

government, as it includes non-governmental (NGO), inter-governmental organisations (IGOs), as well as civil society.[94] With 2025 WHO Nutrition Targets[25] and 2030 SDG[28] deadlines looming, concerted efforts to actively facilitate the necessary inter-sectoral approaches require efforts from all stakeholders to engage so that interventions are not logistically and/or financially prohibitive.

One possible model is that of the South African context where a minister in The Presidency is appointed, overseeing the Department of Planning, Monitoring and Evaluation in order to coordinate planning, monitoring and evaluation of government programmes aimed at improving service delivery, outcomes and impact on society. The main objective of which is to rally around a common set of objectives and priorities to drive development and crosscutting issues.[95] Furthermore, it gathers people from different departments to discuss inter-sectoral issues. Multi- and inter-sectoral approaches require a significant degree of political will, and while gaps across SSA persist in terms of addressing specific sociocultural and political contexts, on a positive note, for the most part across SSA, there are policies concerned with water and sanitation, which furthermore make explicit reference to health and/or nutrition as seen in Table 3.

Moreover, studies linking governance, WASH and nutritional status are increasing, providing a more nuanced perspective on associations on the various components of WASH (Fig. 3). However, much grey literature was not included in this systematic review, most likely due to the peer-reviewed format of scientific publications, thus limiting the body of knowledge included in this review. The authors searched grey literature databases including, the Grey Literature Report in Public Health,[40] African Index Medicus,[41] the WHO Virtual Health Sciences Library,[42] as well as conference proceedings and websites and furthermore reviewed reference lists and where appropriate contacted experts and authors and found that the grey literature concerned with WASH, nutritional status and governance was predominantly located within the IGO and development sector and associated agencies. Examples of this includes the UN through the WHO,[3,39] UN Water,[92] UNICEF,[3,29,31,93] NGOs such as Save the Children[96] and foreign development cooperation agencies such as United States Agency for International Development (USAID).[3]

Grey literature also tended to be narrowly focused on a particular WASH component (either water, or sanitation or hygiene – in particular hand washing) and particular disease context, for instance, tuberculosis, HIV or helminth infections, and while acknowledging the role that nutrition plays, rarely made an explicit link between WASH, nutritional status and governance. WASH is in itself a composite concept comprising individual components each with its own body of research and associated complexities. Part of the complexity for WASH as a consolidated concept and topic for research as well as for service delivery seems to be agreeing upon a common nomenclature and standardised definition of what is being discussed. In this regard, the UN JMP[43,97] and the WHO and UN Water[39,98] have made significant progress in establishing a set of indicators, classifications and units of analysis.

In addition, the bulk of discussions concerned with the nexus between WASH, governance and nutritional status in this systematic review is situated in observational studies and reviews (Fig. 2), thus highlighting the need for more in-depth knowledge on the topic in the various SSA contexts. Surprisingly, no trials were found to form part of the literature under review. This may, in part, be due to the specificity of the search terms. Involvement of various stakeholders and implications for implementation, scalability and policy may not have been reported, specifically in a scientific forum. Furthermore, trials are expensive and while not methodologically required to report on the various interactions with stakeholders are perhaps not explicitly focused on the links to governance structures and civil society as oppose to exploring the biological pathways and determinants.

A 2013 Cochrane Review on the effect of WASH interventions on nutritional status in children highlighted the low number of studies and low methodological quality of studies conducted in the past.[24] As such, the production of high-quality data beyond observational associations is a relatively recent development. Despite recent trial results indicating a marginal effect of WASH interventions on linear child growth,[21,23,24] further exploration of the data from these and forthcoming trials[20,22] will provide a more nuanced perspective on what does and does not work. Broader questions emerge from these results such as, while the microbial quality of drinking water available may be improved, the quantity of water long argued to be a key driver in water-related health gains remains an important consideration.[99,100] Population density and proximity to sanitation facilities are significant drivers in improving environmental conditions around children while delivering community-wide interventions are important for showing an effect of sanitation on linear growth.[21] Other pathways such as nutrition, animal waste and complementary foods as pathways for enteric infection cannot be overlooked. These results show how little we know about the transmission of enteric pathogens, the causes of symptomatic infections and the significance of asymptomatic infections, while at a policy level business as usual in the WASH sector will not be enough to significantly improve child growth.[99]

Conclusion

This systematic review sought to examine the literature linking governance, WASH and childhood nutritional status, in sub-Saharan African settings. The authors found that policy makers would benefit from integrating this emerging evidence-based information into their respective policies in order to better articulate and address the intricacies of WASH in various contexts. Utilising consistent and established terminology when referring to the challenges and recommendations for service provision would allow for a more targeted discussion around which particular aspects of the WASH components require further consideration. The importance of early-life exposures and associations with disease risk in adulthood provides further impetus for tackling WASH from a governance perspective. Neither observational studies nor intervention studies included components exploring the role of governance of WASH in their design nor described if and how actors in the field of WASH were incorporated into the research process. Integrating the role of governance through the involvement of civil society, communities, IGOs, government as well as development agencies would be a recommendation for future studies on the topic. The scientific and research community could further contribute by considering the manner in which study findings could or should be operationalised and gain real-world application. Incorporating WASH components in line with consistent and established terminology and definitions will make study design as well as the results that emanate from such studies more pertinent and reproducible. At the same time, more trials are also needed to determine and to evaluate more effective WASH interventions to halt the vicious cycle of exposure to poor WASH

conditions in early childhood, repeated infections, inflammation and disease risk in adulthood.

Undernutrition has a complex set of political, social and economic causes, none of which are amenable to easy solutions. Important knowledge gaps still remain concerning critical aspects of child undernutrition, including environmental risks in the neonatal and infant periods, especially in sub-Saharan contexts. Vast differences inevitably occur between communities, between urban and rural, between socio-economic and political landscapes, and between regional and global contexts. The complexity of this is further compounded with the realisation that access to water and sanitation is problematised through an increasingly resource and climate-constrained context. Water resources are found in a variety of geographic settings that transcend geopolitical boundaries. Given the complex spatial context and transboundary nature within which water is situated, a number of dichotomies emerge when attempting to analyse national, regional and even continental or global WASH strategies and initiatives.

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Conflicts of Interest. None.

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