




BMJ Open Exploring the association between household access to water, sanitation and hygiene (WASH) services and common childhood diseases using data from the 2017–2018 Demographic and Health Survey in Benin: focus on diarrhoea and acute respiratory infection

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ABSTRACT

Objective The paper aimed to study the association between household access to water, sanitation and hygiene (WASH) services and the occurrence of diarrhoea and acute respiratory infection among children under 5 years in Benin.

Design We performed secondary analyses using Benin's Fifth Demographic and Health Survey datasets. The dependent variables were diarrhoea and acute respiratory infection (yes=1, no=0). Among the independent variables were the household access to individual WASH services, grouped as follows: 'basic', 'limited', 'unimproved' and 'no service'. Multivariate logistic regression was used to determine the association between household access to WASH services and the occurrence of diarrhoea and acute respiratory infection. Results from the multivariate logistic regression were presented using adjusted Odds Ratios (aORs) with 95% Confidence Intervals (95% CIs).

Setting Benin.

Participants Children under 5 years successfully surveyed during Benin's Fifth Demographic and Health Survey.

Outcome measures Diarrhoea and acute respiratory infection.

Results In the current study, 12 034 children under 5 years met the selection criteria and were included in the analyses. The prevalence of diarrhoea and acute respiratory infection was 10.5% (95% CI=9.8% to 11.3%) and 2.9% (95% CI=2.5% to 3.4%), respectively. Children living in households without sanitation service, that is, practising open defecation (aOR=1.9, 95% CI=1.4 to 2.6), and with unimproved (aOR=1.9, 95% CI=1.3 to 2.7) and limited (aOR=1.5, 95% CI=1.1 to 2.2) services were more likely to have diarrhoea compared with children with basic sanitation services. Household access to WASH services was not associated with acute respiratory infection.

Conclusion We suggest reinforcing household access to basic sanitation services to combat diarrhoea in children under 5 years. Further research is needed on the effects

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The study used data from Benin's Fifth Demographic and Health Survey, providing representative findings for the national population of children under 5 years.
- ⇒ It is the first study in Benin focusing on the association between water, sanitation and hygiene, and the occurrence of diarrhoea and acute respiratory infection.
- ⇒ The cases of diarrhoea and acute respiratory infection in the study relied on mother or caregiver reports rather than being confirmed through medical examinations.
- ⇒ The cross-sectional design of the survey prevents establishing a causal relationship between significant factors and the studied disorders.
- ⇒ The interactions among the three components, namely water, sanitation and hygiene, in relation to the risk of diarrhoea and ARI, have not been investigated.

of WASH interventions on diarrhoea and acute respiratory infection in children under 5 years.

INTRODUCTION

Diarrhoeal diseases and acute respiratory infection (ARI) are among the leading causes of morbidity and mortality among children under 5 years.^{1 2} Diarrhoea means passing loose or liquid stools at least three times a day or more frequently than usual for the person concerned.³ It is generally the result of an intestinal infection caused by bacteria, viruses or parasites.³ In 2016, a quarter (1.1 out of 4.5 billion) of all diarrhoea episodes affected children under 5 years, equivalent to 175 per



100 person-years (compared with 61 per 100 person-years in the general population).⁴ During the same year, almost 27% (0.4 out of 1.7 million) of all deaths from diarrhoea were children under 5 years, with a mortality rate of 70.6 per 100 000 (vs 22.4 per 100 000 in the general population).⁴ The spatial distribution of morbidity and mortality due to diarrhoea makes sub-Saharan Africa and Asia the regions where children are most likely to contract and die from the disease.⁴ In 2016, sub-Saharan Africa accounted for about one-third of all diarrhoea episodes (237 per 100 person-years vs 175 per 100 person-years worldwide) and nearly two-thirds of all deaths from diarrhoea (185.7 per 100 000 vs 70.6 per 100 000 worldwide) among children under 5 years.⁴ In Benin, there were 201 episodes of diarrhoea per 100 person-years, with a mortality rate of 290.4 per 100 000.⁴

ARI refers to an illness, usually of viral or bacterial origin, that affects one of the structures of the respiratory system, such as the nose, ears, throat, larynx, trachea, bronchi or lungs.⁵ Lower respiratory tract infections (which affect the trachea, bronchi and lung tissue) and upper respiratory tract infections (which occur in the nasal cavities, pharynx and larynx) are distinguished.^{5,6} In 2019, the highest global incidence and disability-adjusted life-years (DALYs) associated with upper respiratory tract infections were observed in children under 5 years.⁷ According to global estimates, in 2016, 336.5 million (45.5 per 1000) episodes of lower respiratory tract infection occurred, of which 68.1 million (107.7 per 1000) were in children under 5 years.⁸ Globally, mortality due to lower respiratory tract infections in children under 5 years was 103.3 per 1000, compared with 32.2 per 1000 in the general population.⁸ The burden of morbidity and mortality from lower respiratory tract infections in children under 5 years is highest in sub-Saharan Africa.⁸ The region accounts for a quarter (15.8 out of 45.5 million) of lower respiratory tract infection episodes in children under 5 years or 100.6 per 1000.⁸ In addition, the region records half (0.3 out of 0.7) of the deaths related to this condition in children under 5 years, with a mortality rate of 199.5 per 100 000.⁸ In Benin, there were 69.8 episodes of lower respiratory tract infection per 1000, with a mortality rate of 181.4 per 1000.⁸

The result is that children under 5 years in Africa have higher morbidity and mortality related to diarrhoea and ARI than in other regions. In literature, several studies have investigated the predictors of diarrhoea and ARI in children under 5 years. We noted that children under 6 months and over 23 months have lower odds of diarrhoea.^{9–13} The odds of diarrhoea and ARI were higher in children of young mothers than in the ones with older mothers.^{10,12,14–17} Similarly, there is a negative relationship between the mother's level of education with the odds of diarrhoea and ARI in children under 5 years.^{10–14,17,18} Also, children under 5 years living in the wealthiest households appear less likely to suffer from diarrhoea and ARI than those in poorer households.^{9,10,12–16,18} There is also that water, sanitation and hygiene (WASH) conditions could

also play a role in preventing diarrhoea morbidity and mortality in children under 5 years. In many regions, the issue of access to WASH remains a major concern, notably in Africa. In 2020, respectively, only 65%, 33% and 26% of Africans had access to at least basic WASH services, compared with 90%, 78% and 71% worldwide and near-universal coverage in North America and Europe.¹⁹ In Benin, coverage levels are generally lower than those recorded in Africa. Findings of a study on national data from 2017 to 2018 indicated that, respectively, 64%, 13% and 10% of households had access to at least basic WASH services.²⁰ Insufficient access to proper WASH services results in households resorting to unimproved drinking water sources, surface water usage, unimproved latrine utilisation and even open defecation practices, all while neglecting hand hygiene. Unimproved water sources and surface water present an elevated risk of contamination by various pathogens, including bacteria (such as *Legionella*, faecal coliforms, etc) and viruses (such as rotavirus, adenoviruses), among others.^{21–27} Consuming or inhaling water droplets contaminated with these pathogens can lead to diarrhoea and ARI like pneumonia or bronchitis.^{21,22,26–32} Moreover, the practice of open defecation contributes to repeated faecal contamination of the local environment, exposing affected populations to numerous faecal pathogens responsible for causing diarrhoea. Additionally, inadequate hand hygiene promotes the transmission of faecal and respiratory pathogens through droplets and contaminated objects, increasing the risk of contracting diarrhoea or ARI.^{27,33–35} Although the potential of WASH interventions to reduce diarrhoea-related morbidity is widely acknowledged, the evidence, particularly for children under 5 years, is poor.^{36–38} In a 2022 review study, there was no evidence of an association between access to improved water or sanitation and reduced diarrhoea-related morbidity.³⁶ The authors pointed out that children interact differently with the environment than adults; they crawl, ingest objects on the ground, etc, constantly exposing them to pathogenic agents.³⁶ And these constant exposures can limit the effects of WASH interventions on morbidity.³⁶ In the same study, promoting hand hygiene resulted in a 17% reduction in childhood diarrhoea morbidity.³⁶ In considering individual studies, we noted discordant results between WASH and the risk of ARI in children under 5 years.^{10,13–15,18}

After reviewing the literature, it appears that the effects of household access to WASH on diarrhoea or ARI are poorly documented in Benin. This study takes advantage of a large set of representative demographic and health data of the Beninese population at the national level to determine the association between household access to WASH services and the occurrence of diarrhoea and ARI in children under 5 years. We can use the results of this study to strengthen interventions to combat diarrhoea and ARI in children under 5 years by highlighting the at-risk groups based on their basic characteristics, especially those related to WASH.

METHODS

Study setting

Benin is a West African state with 12 535 929 inhabitants in 2021 and an area of 114 763 km².³⁹ Administratively, Benin has 12 departments subdivided into 77 communes. The epidemiological profile of the country shows a major burden of infectious diseases, accounting for about 60% of DALYs.⁴⁰ According to the 2021 Health Statistics Yearbook, the main conditions encountered in consultation and hospitalisation are malaria (43.5%), followed by ARIs (12.3%) and gastrointestinal disorders (5.3%).³⁹ There is a marked epidemiological transition with the emergence of non-communicable diseases and risk factors for non-communicable diseases.^{39 41 42}

Data sources

We performed secondary analyses using datasets from the most recent Benin Demographic and Health Survey (DHS).⁴³ The DHS Programme was initiated by the US Agency for International Development in 1984.⁴⁴ It involved a series of surveys providing demographic and health statistics based on representative samples of women aged 15–49 years, men aged 15–64 years and children under 5 years.^{44 45} In Benin, the DHS are organised by the National Institute of Statistics and Demography (formerly the National Institute of Statistics and Economic Analysis) in close collaboration with the Ministry of Health. In total, Benin has had five DHSs, the most recent in 2017–2018 (DHS-V).^{45–49} After registering on <https://dhsprogram.com/>, the DHS-V datasets for Benin were obtained by request.⁴³

Study population

The study population consisted of children under 5 years successfully surveyed during the DHS-V. Where children were born in multiple pregnancies, we included the 'first' twin. We exclude deceased children, those not usually residing in surveyed households and those with missing data for the variables of interest.

Sampling

The DHS-V used a nationally representative sample of the Beninese population obtained through a two-stage stratified sampling. The territory was first divided into 23 strata (two urban and rural strata per department, except for the entirely urban Littoral). In the first step, a specific number of Primary Sample Units (PSUs) were systematically selected in each stratum with probability proportional to the size (555 in total).⁴⁵ Then, 26 households per PSU were selected, with a systematic draw with equal probability.⁴⁵ Details of the DHS-V sampling procedure and data collection methods are described elsewhere.⁴⁵ All women aged 15–49 years and their children living in the selected households were eligible to be interviewed.⁴⁵ In the current study, 12 034 children under 5 years met the selection criteria and were included in the analyses (figure 1).

Variables

Dependent variables

The dependent variables were diarrhoea (1=yes vs 0=no) and ARI (1=yes vs 0=no). During the DHS-V, these two conditions were reported by the mothers (or caregivers). Diarrhoea was defined as at least three stools of soft or liquid consistency in the two weeks before the day of the surveyor's visit. In addition, the mothers reported whether their children had suffered from coughing with short, rapid breathing associated with a bronchial problem in the two weeks before the survey. In case of a positive response, the involved children were considered to have an ARI.

Main exposures

These were the WASH conditions in which children lived in their households. The WHO/UNICEF Joint Monitoring Programme recommends a five-level scale to group the level of household access to WASH services: 'no service', 'unimproved', 'limited', 'basic' and 'safely managed'.¹⁹ However, the data from DHS-V did not provide information on 'safely managed' WASH services. In the current study, we used a four-level scale ranging from 'no service' to 'at least basic'. In the following, the 'at least basic WASH services' have been labelled simply as 'basic WASH services'. The operational definitions of household access to WASH services according to the four-level scale under consideration are presented in online supplemental table S1. We emphasise that in this document, 'access' and 'coverage' have been considered synonymous terms, referring to the primary utilisation of a given WASH service by households.

Covariables

We had the child, mother (or caregiver) and environment-related variables. The child-related variables were: age in months (<6, 6–11, 12–23, 24–59), sex (male, female), rank (1, 2, 3 and above) and type of birth (twins, single). The mother-related variables were: age (<20, 20–29, 30–39, 40–49), level of education (no formal education, primary, secondary, higher), marital status (couple, single), occupation in the last 12 months (yes, no), religion (no religion, Islam, Christianity and traditional and other), health insurance (yes, no), and exposure to media such as newspapers, radio and television (not at all, less than once a week, at least once a week). Household-related variables included: household head's sex (male, female), wealth index (poorest, poorer, middle, richer and richest) and household size (≤ 5 , > 5). Environment-related variables included: area (urban, rural), department and collection month (November, December, January and February). These variables were identified following a literature review.^{9–18 50–53}

Data analysis

The data analysis took into account the DHS-V sampling. First, the study variables were described based on their weighted frequencies (n) and percentages (%). We

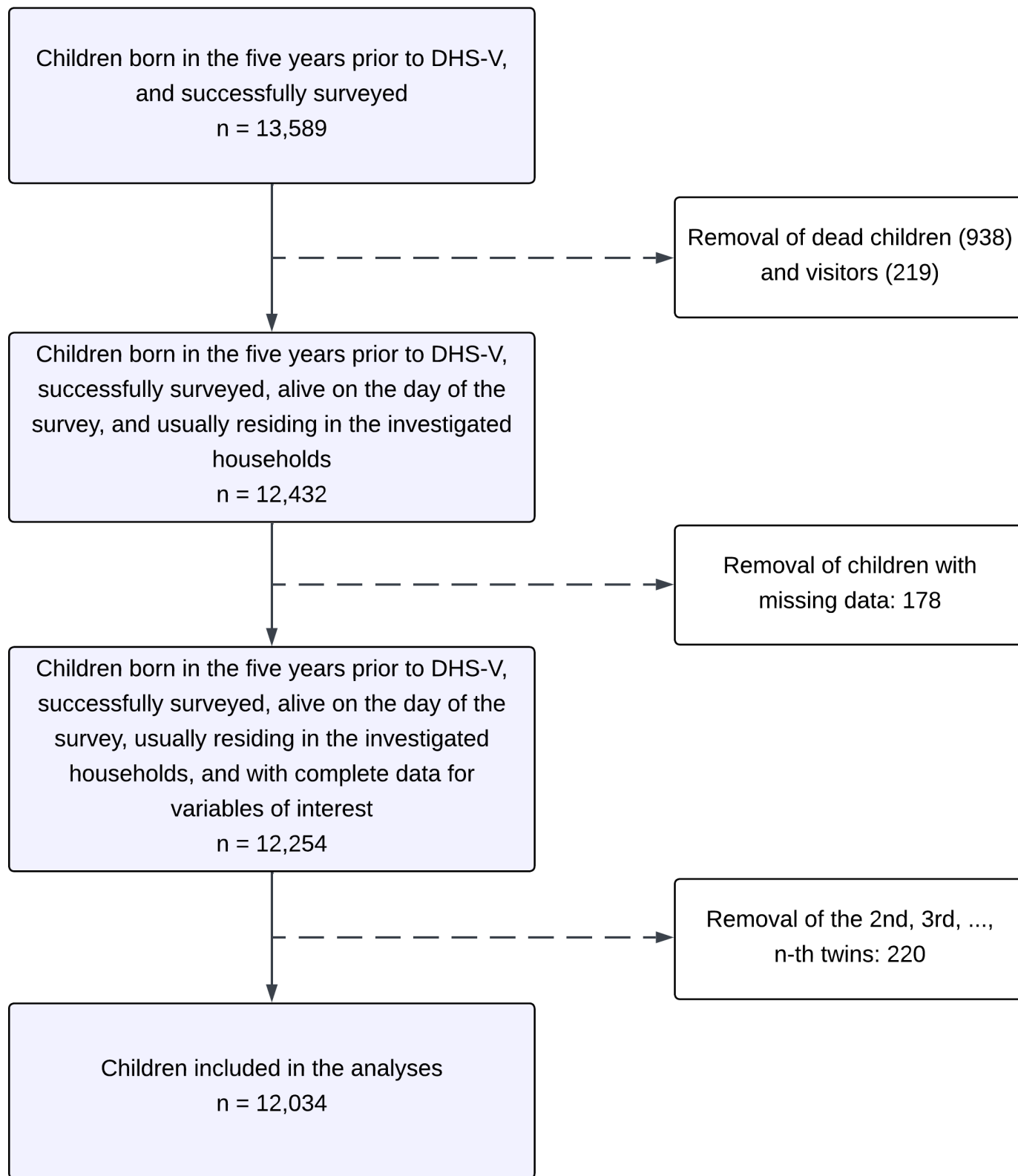


Figure 1 Flow chart for children included in the analyses. DHS-V, Demographic and Health Survey 2017–2018.

calculated the prevalence of diarrhoea and ARI among surveyed children under 5 years with the 95% Confidence Interval (95% CI). Also, we determined the percentage of children covered by WASH services according to the levels with the 95% CI. Second, we identified the factors associated with diarrhoea and ARI by logistic regression.

Independent variables were crossed with each dependent variable using simple logistic regression. The variables significant at 20% were introduced in multivariate logistic regression. By a step-by-step downward strategy, the least significant variable was progressively removed to only have variables with $p < 0.05$. WASH-related variables

were kept in the models regardless of their levels of significance. We presented results as ORs (crude and adjusted) with 95% CI. The Hosmer-Lemeshow test served to verify the goodness of fit of the final models. We performed the analyses using Stata V.15 (Stata Corporation, College Station, Texas, USA).

Patient and public involvement

Participants were not involved in the design or conduct of our research.

RESULTS

Basic characteristics of the study population

Online supplemental table S2 shows the basic characteristics of children under 5 years. Over half (56.8%) were 24 months old or older. There were 50.7% boys and 49.3% girls. There were 2.6% twins. Nearly 6 out of 10 children were third born or higher. In the majority of cases, the surveyed children had mothers who were 20–29 years old (51.6%), uneducated (65.7%), in a relationship (94.1%), Christian (49.6%) and engaged in an income-generating activity (83.2%). Less than 1% (0.9%) of the children had mothers with health insurance. Besides, most of the children's mothers were not exposed to newspapers (94.6%), radio (44.7%) or television (66.1%). The children mostly came from households led by males (84.4%) and with more than five people (62.0%). Less than 40% of the children lived in urban areas. The children in Alibori (13.7%), Borgou (13.4%) and Atlantique (11.2%) were the most represented. Considering the data collection month, 19.0% of the children were surveyed in November, 31.4% in December, 29.5% in January and 20.1% in February.

Prevalence of diarrhoea and ARI

The prevalence of diarrhoea and ARI among the surveyed children under 5 years was 10.5% (95% CI=9.8% to 11.3%) and 2.9% (95% CI=2.5% to 3.4%), respectively.

Access to WASH

Table 1 highlights the level of access to WASH services for children under 5 years in Benin. Among the surveyed children, 58.9% (95% CI=56.2% to 61.5%), 10.6% (95% CI=9.3% to 12.0%) and 8.8% (95% CI=7.8% to 10.0%) lived in households with access to basic WASH services. Besides, 7.0% (95% CI=5.6% to 8.8%), 59.0% (95% CI=56.2% to 61.8%) and 43.3% (95% CI=41.0% to 45.7%) lived in households using surface water as drinking water, practising open defecation and no hand hygiene facilities.

Factors associated with diarrhoea

After univariate analysis, household access to WASH, child's age, child's rank, mother's level of education, mother's marital status, mother's religion, mother's health insurance, mother's exposure to newspapers, radio and television, wealth index, area, department and collection month were identified for multivariate analysis (online

Table 1 Level of access to WASH services for children under 5 years, Benin, 2017–2018

Variables	n	%	95% CI
Water			
No service	843	7.0	5.6 to 8.8
Unimproved	3086	25.6	23.2 to 28.2
Limited	1026	8.5	7.4 to 9.8
Basic	7093	58.9	56.2 to 61.5
Sanitation			
No service	7112	59.0	56.2 to 61.8
Unimproved	1545	12.8	11.3 to 14.5
Limited	2118	17.6	16.0 to 19.3
Basic	1274	10.6	9.3 to 12.0
Hygiene			
No service	5221	43.3	41.0 to 45.7
Limited	5767	47.9	45.6 to 50.2
Basic	106	8.8	7.8 to 10.0
WASH, water, sanitation and hygiene.			

supplemental table S3). After adjusting for confounders, access to sanitation was associated with diarrhoea in children under 5 years (figure 2). Children living in households without sanitation service (aOR=1.9, 95% CI=1.4 to 2.6) and with unimproved (aOR=1.9, 95% CI=1.3 to 2.7) and limited (aOR=1.5, 95% CI=1.1 to 2.2) services were more likely to have diarrhoea compared with children with access to basic sanitation services in their households. There was no evidence in favour of a relationship between household access to water or hygiene with diarrhoea in children under 5 years.

The other factors associated with diarrhoea in children under 5 years in the multivariate analysis were the child's age, child's rank, mother's health insurance, department and collection month (online supplemental table S3). Compared with children 24–59 months old, those under 6 (aOR=1.5, 95% CI=1.2 to 1.8), 6–11 (aOR=3.2, 95% CI=2.7 to 3.8) and 12–23 (aOR=2.7, 95% CI=2.3 to 3.2) months have higher odds of experiencing diarrhoea. Children in the second birth order (aOR=0.8, 95% CI=0.7 to 1.0) were less likely to have diarrhoea than those in the third birth order and above. Children whose mothers lacked health insurance (aOR=6.5, 95% CI=1.4 to 29.6) were more likely to have diarrhoea. Taking Littoral as a reference, the odds of diarrhoea in children under 5 years were higher in Atacora (aOR=2.1, 95% CI=1.4 to 3.1), and lower in Borgou (aOR=0.6, 95% CI=0.4 to 0.9) and Zou (aOR=0.5, 95% CI=0.3 to 0.8). The odds of children developing diarrhoea were lower in December (aOR=0.8, 95% CI=0.6 to 1.0), January (aOR=0.7, 95% CI=0.6 to 0.9) and February (aOR=0.7, 95% CI=0.6 to 0.9) compared with November.

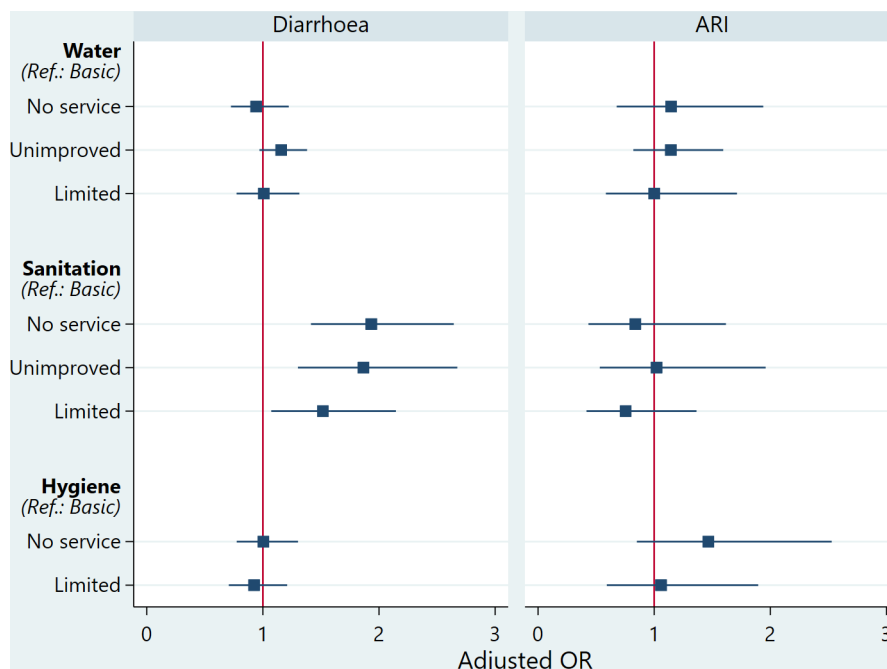


Figure 2 Association between household access to WASH services and the occurrence of diarrhoea and ARI in children under 5 years, Benin. ARI, acute respiratory infection; WASH, water, sanitation and hygiene.

Factors associated with ARI

After univariate analysis, household access to WASH, child's age, mother's level of education, mother's marital status, mother's religion, mother's exposure to television, wealth index, household size, area, department and collection month were identified for multivariate analysis (online supplemental table S4). The household's access to WASH was not associated with ARI in children under 5 years. The factors associated with ARI were the child's age, wealth index, department and collection month. Children under 6 (aOR=1.5, 95% CI=1.1 to 2.1), 6–11 (aOR=1.9, 95% CI=1.4 to 2.6) and 12–23 (aOR=1.5, 95% CI=1.1 to 2.0) months old had higher odds of suffering from ARI than those 24–59 months old. Children from poorer (aOR=2.6, 95% CI=1.3 to 5.3) households are more likely to have ARI than those from the richest households. Taking Littoral as a reference, the odds of ARI in children under 5 years were higher in Mono (aOR=2.4, 95% CI=1.1 to 5.3), and lower in Borgou (aOR=0.3, 95% CI=0.1 to 0.7) and Donga (aOR=0.1, 95% CI=0.0 to 0.4). Children surveyed in December (aOR=1.6, 95% CI=1.1 to 2.3) were at higher odds of ARI than those surveyed in November.

DISCUSSION

In 2010, the United Nations General Assembly recognised the right to safe drinking water, sanitation and hygiene as a human right, and called upon states to intensify efforts to provide safe, clean, accessible and affordable WASH services for all.⁵⁴ 'No child should die or get sick as a result of drinking contaminated drinking water, being exposed to other people's excreta, or having no place to wash their hands'.⁵⁵ However, unfortunately, even today, far too many children around the world are exposed to some

or all of these health risks due to the conditions in which they live in terms of WASH.⁵⁵ By 2019, about 3 million children under 5 years had died from diseases related to WASH.⁵⁶ This study aimed to determine the association between WASH and diseases such as diarrhoea and ARI in children under 5 years.

Among the surveyed children, 10.5% had at least one episode of diarrhoea in the 2 weeks preceding the DHS-V. Comparing this proportion with ones recorded in previous DHS in Benin, stability in the prevalence of diarrhoea in children under 5 years has been noted since 2006: 9.0% in 2006 and 10.1% in 2014.^{47 57} In sub-Saharan Africa, the latest estimates highlight a higher pooled prevalence (15.3%), with 14.4% in West Africa, 14.6% in Southern Africa, 16.0% in East Africa and 18.1% in Central Africa.⁵⁸ In the West African subregion, the prevalence of diarrhoea was: 7.1% in Sierra Leone (2019),⁵⁹ 11.7 in Ghana (2014),⁶⁰ 12.8% in Nigeria (2018),⁶¹ 13.0% in Senegal (2019),⁶² 14.5% in Guinea (2018),⁶³ 15.7% in Liberia (2019–2020),⁶⁴ 17.0% in Mali (2018),⁶⁵ 17.2% in Togo (2017)⁶⁶ and 19.2% in Gambia (2019–2020).⁶⁷ In South Asia, a prevalence ranging from 4.2% in the Maldives to 29.1% in Afghanistan was observed, with an average of 11.5%.⁶⁸ Furthermore, we noted that 2.9% of the children had ARI. At the national level, the prevalence of ARI seems to be trending downward over the past 20 years: 12.0% in 2001, 9.5% in 2006 and 2.6% in 2014.^{47 48 57} According to the latest estimates, the percentage of ARI among children under 5 years in sub-Saharan Africa (8.6%) was higher than what we found.⁶⁹ In the West African subregion, the prevalence of ARI in children under 5 years was: 1.1% in Togo (2017),⁶⁶ 2% in Sierra Leone (2019),⁵⁹ 2.1% in Guinea (2018),⁷⁰ 2.0% in

Mali (2018),⁶⁵ 2.6% in Nigeria (2018),⁶¹ 3.6% in Ghana (2014),⁶⁰ 4.4% in Liberia (2019–2020),⁶⁴ 4.6% in Gambia (2019–2020)⁶⁷ and 5.0% in Senegal (2019).⁶² In Indonesia, 4.2% of children under 5 years suffer from ARI in a study in 2022.¹⁵ In Bangladesh, 5.4% of children under 5 years had ARI.¹⁴

In the present study, we first sought to test the association between inadequate water services with diarrhoea and ARI. Other studies have observed that unimproved water services, including surface waters, are more likely to be contaminated by germs responsible for diarrhoea and ARI.^{21–32} In the current study, after adjusting for potential confounders, we did not find a significant relationship between diarrhoea in children under 5 years and the water conditions in their households. It supports the conclusions of previous studies in Africa and Asia.^{9 10 12 13 16 17 50 52} Concerning ARI, we also did not observe a significant relationship between the occurrence of this condition and access to drinking water services. Other studies have also been unable to find a significant relationship between these two variables.^{10 13–15} Basic water points are those that can deliver safe water due to their design and construction, while also being readily accessible (less than 30 min away). The fact that we have not observed a lower risk of diarrhoea or even ARI among children living in households covered by these installations may indicate unhygienic and unsanitary behaviour between water collection and its actual use for the child. Therefore, it would be relevant to encourage households to adopt, as much as possible, water purification practices before consumption, even if the water comes from a basic-level source.

We observed that children living in households with basic sanitation services had lower odds of diarrhoea than others, which supports the results of other studies.¹¹ As a reminder, basic sanitation services are improved facilities (those designed to prevent human contact with excrement) which are not shared with other households.¹⁹ Compared with children living in households with basic sanitation, those from ones with limited or unimproved sanitation and practising open defecation were from 1.5 to 1.9 times more likely to experience diarrhoea. Faecal contamination of the local environment resulting from open defecation would repeatedly expose populations near the defecation sites, including children, to numerous faecal pathogens. Furthermore, unimproved sanitation facilities due to the absence of effective excreta disposal technology increase the risk of contamination of users with pathogens during defecation and subsequent transmission to children. As for limited sanitation services, although they are based on improved technologies, they have the disadvantage of being shared with other households. The high frequency of use of these facilities is likely to encourage the contamination of adult users with infectious agents and, thus, the transmission of pathogenic agents from adult users to children.⁵³ This provides evidence in favour of increasing household access to basic sanitation services to combat diarrhoea in children under

5 years. Furthermore, as in the present study, we have not come across any studies that have observed an association between the level of access to sanitation and ARI in children under 5 years.

We did not observe a significant association between diarrhoea and ARI with household access to hand hygiene services. The availability of a hand hygiene station in the household may not necessarily imply the systematic practice of hand hygiene at critical times, such as before eating or after defecation.¹³

Other factors associated with diarrhoea in children under 5 years were the child's age, child's birth order, mother's health insurance, department and collection month. The predictors of ARI were the child's age, wealth index, department and collection month. Compared with children aged 24–59 months, younger children (0–23 months) were more likely to have diarrhoea or ARI. The low morbidity risk among older children could be due to the immunity they acquire and strengthen over time. Specifically, the highest ORs for diarrhoea were in the 6–11 months and 12–23 months age groups. It corroborates the results of other studies.^{10–18} With weaning, there is a start of the consumption of potentially non-hygienic foods among children who have been mainly breast fed until 6 months and with a still developing immune system.^{10 11 13–16 18} According to our results, first-born children were at a lower risk of developing diarrhoea than others. It could be due to the excitement and joy surrounding first births in Africa, which prompts parents to protect their children from preventable diseases.⁷¹ Over time, however, this motivation may decrease with subsequent births.

Children whose mothers were covered by health insurance were less at risk of developing diarrhoea than children of uninsured mothers. The latter might benefit from better access to preventive and curative care.

This study highlights a negative relationship between household wealth index and ARI in children under 5 years. This result is in line with other studies.^{10 14 15 18} People living in poverty are exposed to risk factors for respiratory diseases, such as poor indoor air quality, overcrowding, unsanitary conditions, and limited access to healthcare and health services.¹⁰

The odds of developing diarrhoea and ARI were not homogeneous within the department. Taking Littoral as a reference, the odds of diarrhoea in children under 5 years were higher in Atacora and lower in Borgou. The risk of ARI in children under 5 years was higher in Mono. Further studies are needed to identify the sociocultural and behavioural determinants that drive excess morbidity in these geographical areas. Furthermore, the odds for children to develop diarrhoea were lower in December, January and February compared with November. Besides, the odds of ARI in children under 5 years were significantly higher in December than in November. It reflects the seasonal nature of these two conditions. In the case of ARI, the month of December in Benin coincides with the harmattan, which is a dry wind carrying dusty particles

that can irritate respiratory passages and worsen symptoms of certain respiratory diseases.

Strengths and limitations

One of the study's strengths was the use of data from the fifth edition of the DHS in Benin, making the results representative of the national population of children under 5 years. This is the first study in Benin on predictors of diarrhoea and ARI that focuses on water, sanitation and hygiene. However, due to the cross-sectional design of the survey, a causal relationship cannot be established between the significant factors and the disorders considered. Cases of diarrhoea and ARI were reported by mothers (or caregivers) and were not subjected to a medical examination. Therefore, the notification of diarrhoea and ARI episodes in children under 5 years depends on their ability to recognise symptoms. Our results suggest that the risk of diarrhoea and ARI episodes in children under 5 years varied significantly according to the month. The DHS-V, whose data were used, was conducted from November 2017 to February 2018. If the survey had been conducted during a different period, it cannot be ruled out that the prevalence would have been significantly different. Lastly, the interactions among the three components, namely water, sanitation and hygiene, in relation to the risk of diarrhoea and ARI, have not been investigated.

CONCLUSION

We found that 10.5% and 2.9% of children under 5 years had diarrhoea and ARI, respectively. Household access to basic sanitation services was associated with a significantly reduced risk of diarrhoea in children under 5 years. Household access to WASH was not associated with ARI in children under 5 years. We suggest reinforcing household access to basic sanitation services to combat diarrhoea in children under 5 years. Further research is needed on the effects of WASH interventions on diarrhoea and ARI in children under 5 years, taking into account the interactions. Other predictors of diarrhoea and ARI in the participants were the child's age, child's birth, mother's health insurance, wealth index and department and collection month. This study provides evidence for the design of post-weaning infant health information, education and communication programmes, promotion of mothers' subscription to health micro-insurance and poverty reduction as part of the fight against diarrhoea and ARI in children under 5 years. Longitudinal studies are an option to investigate the seasonal component of the prevalence of diarrhoeal diseases and ARIs. Qualitative studies are one way to better understand the disparities in the prevalence of diarrhoea and ARI at the departmental level.

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Data availability statement Data are available upon reasonable request. The DHS-V datasets for Benin are available free of charge upon request after registration at <https://dhsprogram.com/>.

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