# The relationship between the WASH,morbidity,and childhood undernutritionamong the Wogo, an island community in western Niger.

**Original Research Article**

**Abstract**

In Niger, diseases linked to poor WASH (Water, Sanitation, Hygiene) practices are one of the main causes of morbidity and mortality among children under five.

This study aimed to evaluate the relationship between WASH and morbidity and the nutritional status of children aged 0 to 59 months in the rural island commune of Wogo de Sinder, located in the Tillabéry region in the West. of Niger.

This cross-sectional descriptive study involved a representative and random sample of mothers of children aged 0 to 59 months. A questionnaire was completed through a structured interview. The data were collected with ODK software and then analysed with SPSS and Epi Info version 7.2.

A total of 250 mothers were enrolled. The study shows that most mothers surveyed used surface water (90%) for drinking water, while 10% used groundwater. Around 49.2% of mothers said that their home is on the banks of the river, compared to 36.8% who lived less than 30 minutes away. Their main water storage containers are jars and buckets, with 42.4% and 36.6%, respectively. Among the respondents, 40.4% did not practice any water treatment, 53.2% filtered the water with a cloth, and 6.4% treated the water with bleach. Only 21.6% of mothers washed their hands with soap after using the toilet or feeding the infant. About 72% of households did not have a latrine. Wasting, underweight and stunted growth affected 31.2%, 41.6%, and 43.2% of children whose mothers did not wash their hands with soap. Morbidity affected 35.2% of children whose mothers used surface water for drinking water.

WASH knowledge and practices remain inadequate in the rural commune of Sinder and negatively affect the nutritional and health status of children under 5.

**Keywords**: Wash, child morbidity, malnutrition, Wogo, Sinder, islander, Tillabery/Niger.

## 1. Introduction

Malnutrition is a set of manifestations due to inadequate food intake, in termsof quantity and/or quality, whether this set manifests itself clinically or is only detectable by biochemical, anthropometric, or physiological analyzes[1]. It is established that in protein-calorie malnutrition, there is hypo albuminemia which is linked to a reduction in inputs through lack of food intake, malabsorption, digestive leaks and a reduction in hepatic synthesis. This hypoalbuminemia is linked to an increase in catabolism secondary to an infectious, inflammatory or malignant disease[2].

Lack of access to water, sanitation, and hygiene (WASH) is one of the leading causes of child undernutrition [3], [4], [5]. Indeed, inadequate WASH promotes the transmission of infectious diseases, which are significant factors favoring child undernutrition[6], [7]. Healthy WASH practices include adequate sanitation, safe drinking water, hand washing with soap, food hygiene, safe child feeding facilities, and a clean play environment[8].

In 2010, equitable access to water, hygiene, and sanitation was recognized by the United Nations (UN) General Assembly as a human right; then, the same decision was reaffirmed the same year by the Human Rights Council [9]. Indeed, around 1.8 billion people drink water contaminated by faces, and 2.4 billion people do not have access to appropriate sanitation, of which around a billion defecate in the air free[10].

Promoting hygiene and guaranteeing access to drinking water and sanitation has proven effective in reducing cases of child undernutrition, as has been reported in Peru[11], Brazil[12], India[13], Mali[14] and Ethiopia[9]. Other authors have also reported a positive association between improved WASH conditions and child growth[13], [15]. Thus, a reduction in open defecation[16] and improved sanitation coverage[17] at the community level have been associated with a reduction in stunting.

In Niger, water-related diseases and poor hygiene and sanitation practices constitute one of the leading causes of morbidity and mortality among children under five[18].

The objective of this study is to evaluate the relationship between WASH and morbidity of childrenandchildhood undernutritionaged 0 to 59 months among the Wogo, an island community in western Niger.

## 2. Methodology

### 2.1 Study area

This study was conducted in the island rural community of Sinderon the Niger River(figure 1). It covers an area of 300 $km^2$ and comprises around fifty islands. It is located in the Tillabéry region (15°2’27’’N 2°42’18’’E), one of the eight (8) regions of Niger. Twelve (12) villages were the subject of this study by drawing lots.

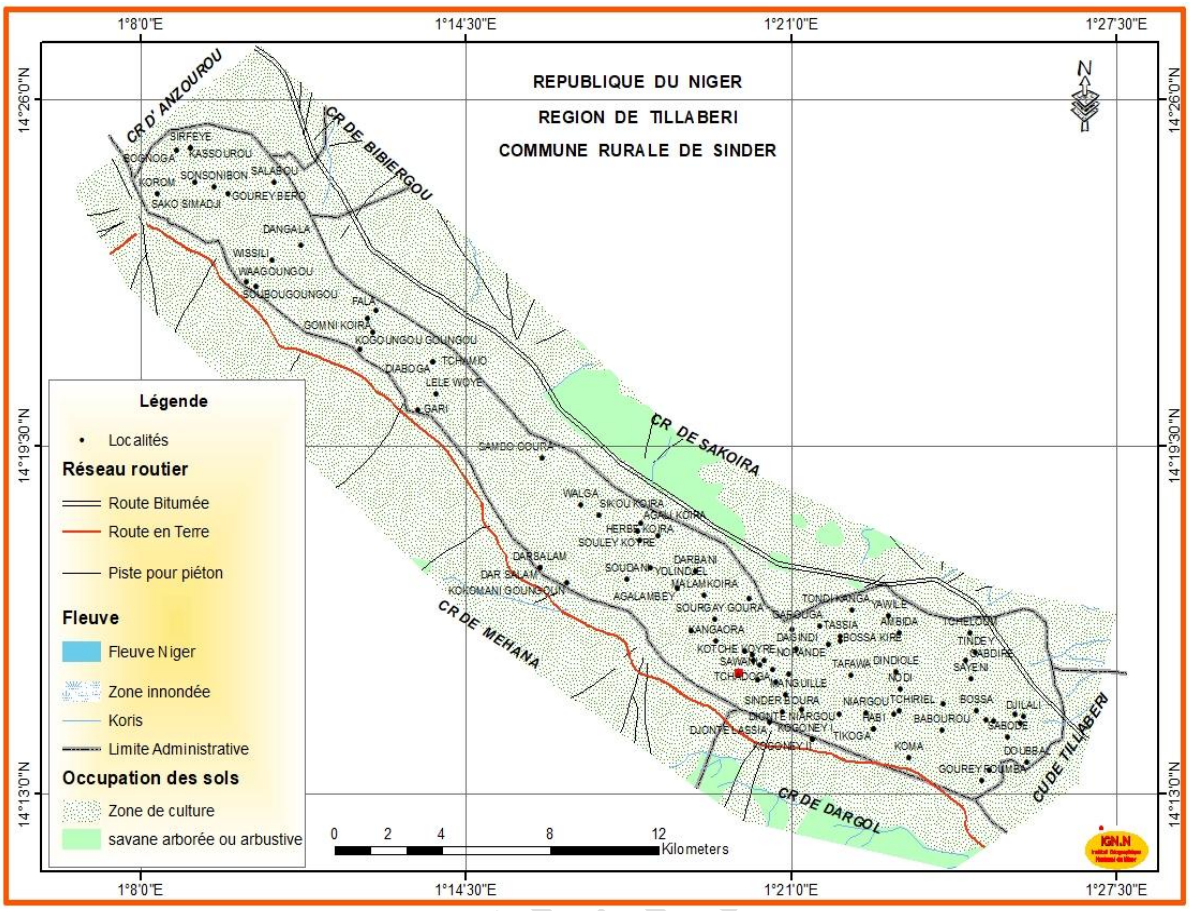


*Figure 1: Map of the island rural community of Sinder*

## 2.2 Type, Period and duration and study population

This is a descriptive cross-sectional study with two passages. The 2 visits to the study area were carried out just after the harvests (October-December) and during the lean period (June–August) of 2021. Questionnaires on access to water, Hygiene, and sanitation were administered to a representative sample of mothers of children aged 0 to 59 months. The children's anthropometric parameters were measured.

## 2.3 Inclusion criteria and ethical considerations

The study was approved by the Scientific and Academic Council of the University and authorized by regional and municipal administrative authorities. The protocol conformed to the 1975 Declaration of Helsinki, as revised in 2008. Participation in the study was voluntary. All mothers with children aged 0 to 59 months whose informed consent was obtained were included in the study. No biological samples of any kind were taken.

## 2.4 Data collection and processing

The ODK Open Data Kit software was used for data collection and processing with SPSS software (version 28.0). IBM Corp. Released in 2021. IBM SPSS Statistics for Windows, Version 10. Armonk, NY: IBM Corp and Epi info software version 7.2. Atlanta Center for Disease Control and Prevention (CDC), United States, in collaboration with the World Health Organization (WHO), free software tools for public health practitioners and researchers worldwide.

## 3. Results

The survey made it possible to enlist 250 breastfeeding or non-breastfeeding mothers of children aged 0 to 59 months, volunteers from the rural commune of Sinder in the Tillabéry region of Niger.

Table I shows that only 10% of mothers used borehole water; the rest drew their water directly from the river. Around 49% of mothers live on the banks of the Niger River, and 37% live less than 30 minutes from the banks. In households, water is mainly stored in jars (42.4%), buckets (36%), and cans (20%). When the river is flooded, the mothers surveyed do not use any treatment to make the water drinkable. The only precaution taken was to go at dawn to draw water before the children's bathing, laundry, and washing up began. During the rainy season, the river water is contaminated by impurities and mud from the tributaries that flow into it. During this period, approximately 59.6% of mothers treated drinking water. The treatment processes are decantation with Alum plus fabric filtration (53.2%) and simple decantation plus bleach (6.4%). Mothers use potassium alum (a double salt of potassium aluminum sulfate (Kal(SO4)2.12H2O) which they pour into the cloudy water while stirring it with a spatula to precipitate impurities; after this operation, they use nylon fabrics to filter it. This method is only used in winter when the surface water is cloudy.

*Table 1: Distribution of mothers according to the source, accessibility, method of storage, and type of drinking water treatment.*

| **Parameters** | %(N) |
|---|---|
| **Source of drinking water supply** | |
| Drilling | 10(25) |
| Surface water | 90(225) |
| **Travel time to get water** | |
| Water on site | 49.2(123) |
| Less than 30 mins | 36.8(92) |
| 30 min or more | 14(35) |
| **Water storage in the household** | |
| Cans | 20(50) |
| Jars | 42.4(106) |
| Buckets | 36.4(91) |
| Others | 1.2(3) |
| **Water treatment to make it drinkable** | |
| No treatment | 40.4(101) |
| Alum Treatment + Filtration | 53.2(133) |
| Decantation + Bleach | 6.4(16) |

The number in parentheses indicates the number of mothers: %(N).

Table II shows that washing hands after returning from the toilet or before feeding the child is practised by 21.6% of mothers, among whom 5.6% wash their hands with soap when returning from the toilet before feeding the child.

*Table 2: Hand washing with soap by mothers and using latrines in households.*

| **Parameters** | %(N) |
|---|---|
| **Hand washing with soap at critical times** | |
| Yes | 21.6(54) |

| | |
|---|---|
| No | 78.,4(196) |
| Total | 100(250) |
| **Critical times for handwashing with soap** | |
| When returning from the toilet | 13.6(34) |
| Before feeding the child | 2.4(6) |
| After returning from the toilet and before feeding the child | 5.6(14) |
| **Total** | 21.6(54) |

The number in parentheses indicates the number of mothers: %(N)

Table III presents the practice of drinking water treatment according to the mother's education level. Educated mothers. even those with elementary education. tend to treat water before consumption ($p$ = .0012).

*Table 3: Practice of drinking water treatment according to mothers' education level.*

| Level of Schooling | No treatment | Filtration | Bleach | Total | P-value |
|---|---|---|---|---|---|
| Never attend school | 31.6(79) | 34(85) | 2.8(8) | 68.8(172) | |
| Primary | 5.6(14) | 11.2(28) | 2(5) | 18.8(47) | .0012 |
| Secondary + Higher | 3.2(8) | 8(20) | 1.2(3) | 12.4(31) | |
| Total | 40.4(101) | 53.2(133) | 6.4(16) | 100(250) | |

The number in parentheses indicates the number of mothers: %(N).

Table IV shows that children whose mothers do not wash their hands with soap at critical times are significantly more affected by acute malnutrition (p=.0023). Likewise, the prevalence of SAM is significantly higher in these children ($p$=.0015).

*Table 4: Distribution of childhood acute malnutrition (AM: low weight/height) according to hand washing with soap after returning from the toilet and/or before giving food to the child.*

| Hand washing | Total | Without AM | AM | Probabilité p | AM | | P-value |
|---|---|---|---|---|---|---|---|
| | | | | | MAM | MAS | |
| With soap | 21.6(54) | 13.2(33) | 8.4(21) | .0023 | 6.9(17) | 1.6(4) | .0015 |
| Without soap | 78.4(196) | 47.2(118) | 31.2(78) | | 21.2(53) | 10(25) | |
| Total | 100(250) | 60.4(151) | 39.6(99) | | 28(70) | 11.6(29) | |
| Time to wash your hands with soap | | | | | | | |
| I+II | 16(40) | 8.4(21) | 7.6(19) | .047 | 6(15) | 1.6(4) | .036 |
| III | 5.6(14) | 4.8(12) | 0.8(2) | | 0.8(2) | 00.0(0) | |
| Total | 21.6(54) | 13.2(33) | 8.4(21) | | 6.8(17) | 1.6(4) | |

The number in parentheses indicates the number of mothers: %(N). AM: acute malnutrition; MAM: moderate acute malnutrition; SAM: severe acute malnutrition; MAG: global acute malnutrition. I+II: Group of mothers who wash their hands with soap either after returning

from the toilet or before feeding their children. III: Group of mothers who wash their hands with soap after returning from the toilet and before feeding their children.

Table V shows that the prevalence of childhood global malnutrition (GM: low/weight/age) is not significantly associated with mothers' hand washing with soap at critical times (p = 0.079). However, the SGM rate was significantly higher in children whose mothers did not wash their hands with soap at critical times (*p*=.036).

*Table 5: Distribution of overall childhood malnutrition (MG: low weight/age) according to hand washing with soap after returning from the toilet and/or before giving food to your child.*

| Hand washing | Total | Without MG | MG | P | MG | | P-value |
|---|---|---|---|---|---|---|---|
| | | | | | MGM | MGS | |
| With soap | 21.6(54) | 12.4(31) | 9.2(23) | .079 | 6.4(16) | 2.8(7) | .036 |
| Without soap | 78.4(196) | 36.8(92) | 41.6(104) | | 30(75) | 11.6(29) | |
| Total | 100(250) | 49.2(123) | 50.8(127) | | 36.4(91) | 14.4(36) | |
| | | | | | | | |
| I+II | 40 | 7.6 (19) | 8.4(21) | .049 | 6.4(16) | 2(5) | .068 |
| III | 14 | 4.8(12) | 0.8(2) | | 00.0(00) | 14.30(2) | |
| Total | 54 | 12.4(31) | 9.2(23) | | 6.4(16) | 2.8(7) | |

The number in parentheses indicates the number of mothers: %(N). MG: global malnutrition; MGM: moderate global malnutrition; SGM: severe global malnutrition. I+II: Group of mothers who wash their hands with soap either after returning from the toilet or before feeding their children. III: Group of mothers who wash their hands with soap after returning from the toilet and before feeding their children.

Table VI shows that the prevalence of childhood chronic malnutrition (CM: low/weight/age) is not significantly associated with mothers' hand washing with soap at critical times (p = 0.074). On the other hand, the degree of chronic malnutrition severity significantly differs between the two groups of children (*p*=.015).

*Table 6: Distribution of chronic malnutrition (CM: low height/age) in children according to hand washing with soap after returning from the toilet and/or before feeding your child.*

| Hand washing | Total | Without MC | MC | P | MC | | P-value |
|---|---|---|---|---|---|---|---|
| | | | | | MCM | MCS | |
| With soap | 54 | 14.0(35) | 7.6(19) | .074 | 4.8(12) | 2.8(7) | .015 |
| Without soap | 196 | 35.2(88) | 43.2(108) | | 32(80) | 14.28(28) | |
| Total | 250 | 49.2(123) | 50.8(127) | | 36.8(92) | 14(35) | |
| | | | | | | | |
| I+II | 40 | 57.50(23) | 42.50(17) | .035 | 40.0(16) | 12.50(5) | .056 |
| III | 14 | 87.72(12) | 14.28(2) | | 00.0(00) | 14.30(2) | |
| Total | 54 | 14(35) | 7.6(19) | | 4.8(12) | 2.8(7) | |

The number in parentheses indicates the number of subjects %(N). MC: chronic malnutrition; MCM: moderate chronic malnutrition; MCS: severe chronic malnutrition. I+II: Group of mothers who wash their hands with soap either after returning from the toilet or before feeding their children. III: Group of mothers who wash their hands with soap after returning from the toilet and before feeding their children.

Table VII shows that the source of drinking water is a risk factor for child morbidity (p = 0.025). Thus 39% of children who consume river water tend to be sick more often compared to 28% among those consuming groundwater (*p*=.025).

*Table 7: Prevalence of child morbidity depending on water used as a drink.*

| **Sources of water used for drinking** | **Disease frequencies** | | Total | P-value |
|---|---|---|---|---|
| | Yes | No | | |
| **Groundwater**%(N) | 2.80(7) | 7.2(18) | 10(25) | .025 |
| **Surface water** %(N) | 35.2(88) | 54.8(137) | 90(225) | |
| Total | 38(95) | 62(155) | 100(25) | |

The number in parentheses indicates the number of mothers: %(N).

Table VIII shows that illnesses are as common among children whose mothers wash their hands with soap as among those whose mothers do not wash their hands with soap. However, this relationship is not significant (*p*=.23).

*Table 8: Recurrence of child morbidity according to hand washing with soap.*

| **Hand washing** | **Recurrence of childhood morbidity** | | Total | P-value |
|---|---|---|---|---|
| | Yes | No | | |
| With soap | 9.6(24) | 12.0(30) | 21.6(54) | .23 |
| No hand washing with soap | 28.4(71) | 50(125) | 78.4(196) | |
| Total | 38.0(95) | 62.0(155) | 100(250) | |
| Time to wash your hands with soap | | | | |
| I | 6.4(16) | 7.2(18) | 13.6(34) | |
| II | 1.6(4) | 0.8(2) | 2.4(6) | .28 |
| III | 1.6(4) | 4.00(10) | 5.6(14) | |
| Total | 9.6(24) | 12.00(30) | 21.6(54) | |

The number in parentheses indicates the number of mothers: %(N). I: Group of mothers who wash their hand with soap after returning from the toilet; II: Group of mothers who wash their hand with soapbefore giving food to the child; III: Group of mothers who wash their hand with soap after returning from the toilet and before giving food to the child.

Table IX shows that diarrhea ($p$ = .02), acute respiratory infections, and cough ($p$=.02) affect children who consume surface water significantly more than groundwater. On the other hand, there is no significant link between fever ($p$ = .26) and malaria ($p$ = .07) and the source of drinking water.

*Table 9: Distribution of the mother population according to the types of child morbidity and drinking water consumed.*

| Morbidity | Under groundwater %(N) | | Surface water%(N) | | Total | P-value |
|---|---|---|---|---|---|---|
| | Yes | No | Yes | Non | | |
| Diarrhea | 1.6(4) | 8.4(21) | 22.4(56) | 67.6(169) | 100(250) | .02 |
| Fever | 4(10) | 6(15) | 26.8(67) | 63.2(158) | 100(250) | .26 |
| AKI/Cough | 2.8(7) | 7.2(18) | 12.4(31) | 77.6(194) | 100(250) | .02 |
| Malaria | 2(5) | 8(20) | 12.4(31) | 77.6(194) | 100(250) | .07 |

The numbers in parentheses indicate the number of mothers: %(N). ARI: Acute Respiratory Infections.

Table X shows that 63.15% of heads of households with a secondary or high level of education, 9.16 % with a primary level, and 31.5% who never attended school own a latrine. Latrine ownership is significantly linked to the level of education of the head of household ($p$ = .0051)

*Table 10: Possession and use of latrines according to household heads' education level.*

| Level of education Possession of latrines | Possession of latrines | | Total | P-value |
|---|---|---|---|---|
| | No | Yes | | |
| Never gone to school | 20(50) | 9.2(23) | 29.2(73) | .0051 |
| Primary | 43.6(109) | 4.4(11) | 48(120) | |
| Secondary + higher | 8.4(21) | 14.4(36) | 22.8(57) | |
| Total | 72(180) | 28(70) | 100(250) | |

The number in parentheses indicates the number of mothers: %(N).

## 4. Discussion

### 4.1. Access, storage, and treatment of drinking water

According to the World Health Organization, no child should die or become ill because of drinking contaminated drinking water. Unfortunately, far too many children worldwide still consume drinking water from unimproved sources [19]. Thus, in 2015, approximately 11.5% of the world's population still did not have access to basic drinking water services. Around 10% of the population in sub-Saharan Africa still draws drinking water directly from surface water [19]. During the present study, 90% of the households surveyed drew their drinking water directly from the Niger River, compared to 10% who used groundwater (drilling).

These island populations are, therefore, directly exposed to all diseases linked to poor-quality water. In 2012, in Niger and rural areas, around 39% of households surveyed obtained drinking water from an unimproved source, of which 1.4% used surface water[20]. In 2019, the proportion of the population using unimproved water sources increased to 30.7% nationally and 36.30% in rural areas, and that of the population consuming surface water to 00% [21]. However, these results were not confirmed by the 2022 SMART survey, which estimated that 39% of the population used unimproved sources and 3.9% of the population consumed unprotected surface water[22]. In this island population surveyed, households almost use surface water as drinking water, well above the national average. Several reasons could explain this high surface water consumption, including the river banks' proximity. Around 50% of mothers claimed to live right on the banks of the rivers, while 36.5% were less than 30 minutes from the banks, and only 14% lived more than 30 minutes from the banks of the Niger River. Unavailability of drilling. Among the villages surveyed, only one village had a public borehole that was still operational at the time of the survey. In Benin, in villages where hydraulic works often break down, populations consume 55% of river water[23]. The quality and cost of borehole water would be another factor. Households who consumed borehole water complained of its salty taste and high purchase price: 25 CFA francs at (0.038 Euros) per 25 L container. According to the results of this survey, access to a safely managed drinking water supply service constitutes a public health concern for these island populations.).

### 4.1.1 Water storage

In households, water was mainly stored in commonly used containers such as jars, buckets, and cans, with a frequency of 42.4%, 37.6%, and 20%, respectively. Previous studies had reported from Benin[23], Mali [24], and Ivory Coast [25], that jars, terracotta pots, cans, barrels as well that basins and buckets were the main water storage containers in households. Storing water can cause contamination and bacterial proliferation[26]. Indeed, storage containers mostly have wide openings that are not well covered in most households, thus exposing their water contents to contamination [27].

### 4.1.2. Treatment of drinking water

The fundamental objective of water treatment is to protect consumers from pathogenic microorganisms and impurities that are unpleasant or dangerous to health, especially in children under five years of age[10], this study, around 40% of mothers did not treat their water before consumption. During the EDSN-MICS IV 2012 survey, around 80% of households in rural areas and 83% of households nationally did not use any means of treating their drinking water [20]. In the rural commune of Lokossa (Benin), authors reported that around 79% of households surveyed do not use any drinking water treatment process[28]. These results are twice as high as our observations. Only a third of households in a working-class neighborhood of Abidjan in the Ivory Coast use their drinking water [25]. This percentage is even lower nationally, with an average of 10% of households [26].

Generally speaking, the population would not consider it necessary to treat drinking water if the contamination of the latter does not appear clearly to them [29], [30], [31], [32]. Among the methods used by households to make water drinkable were filtering through a cloth (86%), adding Aqua tabs (chlorine tablets, 6%), filtering through ceramic, sand or other filters. (2.5%), adding bleach (1%) and boiling (0.5%)[20]. During the present study, 53% of households used Alum treatment followed by filtration, and 6.4% used decantation followed by bleaching. In Mali, the most used home water treatment methods are the use of liquid

chlorine (bleach) 35.5%, the membrane filter (sieve) (32.6%), and the plastic filter. fabric (28.0%). Methods such as the use of chlorine tablets (Aqua tab) (9.9%), decantation (4.4%), and ceramic filtering are known in relatively small proportions[24]. In the Ivory Coast, the methods most used in the working-class neighborhoods of Abidjan are bleaching, filtration, boiling, and decanting [25]. These treatment means do not vary significantly depending on the city or the countryside [26]. In Senegal, bleaching is practiced by 14% of households in rural areas [33]. The low rate of water bleaching observed during the present study could be linked to ignorance of the need for the practice or the dosage of bleach [34].

#### 4.1.2.1. Treatment of drinking water according to mothers' education level.

The mother's educational level variable is a factor associated with water treatment. Thus 46% of non-school mothers do not apply any drinking water treatment compared to 30% of mothers at primary level and 26% at secondary + higher level. The difference is very significant ($p$ = .0012). According to Vallin (1989), "Education gives mothers access to a certain amount of knowledge which, even elementary, will allow them to be much more effective in their role as mothers." Education provides mothers with the ability to distinguish among the practices in force in the community; those that promote the good health of the child and those likely to expose children to the risk of illness [35], a study carried out in Benin shows that 37.8% of illiterate and illiterate mothers interpret illnesses as bodily illnesses resulting from bad luck [36]. According to them, it is inconceivable that water causes illnesses because it is this water that has always been drunk by the ancestors and the latter also recommended it to them.

### 4.2. Hand hygiene and child morbidity.

Handwashing with soap (HHS) is recognized as a cost-effective intervention to reduce morbidity and mortality associated with enteric infections, especially in children under 59 months [7]. Indeed, when there is no hand washing after critical moments, the risk of fecal-oral transmission is all the greater [37]. Unfortunately, only 3-34% of the population in developing countries regularly wash their hands with soap at critical times during the day [38]. In the rural commune of Sinder, only 21.6% of mothers say they wash their hands with soap at critical times. In Burkina Faso, the practice of washing hands with soap is estimated at only 17% in 2015 within the population [39].

In Madagascar, 70% of respondents confirm having received information on washing hands with soap or ashes. Two-thirds (65%) say they use soap to wash their hands. Among those who have never used soap to wash their hands, more than four in five (85%) said the main reason was not having money to buy soap [40].

Most mothers in the rural commune of Sinder (78.4%) do not perceive the importance of washing hands with soap in preventing illness. In the rural commune of Ngohé in Senegal, hand washing with soap at critical times was ignored by 94% of mothers [41]. The global average of handwashing has been estimated at 19% [42]. This low prevalence of adequate hand hygiene is believed to be the cause of nearly 300,000 deaths per year, with the majority of deaths occurring among children under 5 years old [43]. Unfortunately, many mothers often think that only visible dirt or smelly hands are likely to cause illness, and even then, they rarely make an explicit link between dirty hands, diarrhea, and illness [44]. However, it has been reported that washing hands after defecating and touching faces, before food preparation, and before consuming food could minimize the risk of diarrhea [45].

Specifically, several studies have reported that hand washing with soap, especially after contact with faeces, can reduce diarrheal incidence by 25–53% in children under 5 years of age [46], [47], [48], [49], and respiratory infections by 30% [50]. However, in the present study, children whose mothers say they practice hand washing with soap are more often sick, 44.44% compared to 36.22% of children whose mothers do not wash their hands with soap. This could be due to poor hand-washing practices, suboptimal hygienic conditions, or an unsanitary environment.

### 4.3. WASH and child undernutrition

In 2018, almost 39% of children under 5 in Africa were estimated to be stunted and 28% wasted [51]. The prevalence of global acute malnutrition, underweight, and chronic malnutrition is very worrying in the child population studied, with respective prevalence rates of 39.6%, 51%, and 51%. Among the three main forms of undernutrition, stunting is said to be the most prevalent among children under 5 years old [52]. During this study, the prevalence of underweight was as high as that of stunting.

The prevalence ($p$ = .0023) and the degree of severity ($p$=0.0015) of global acute malnutrition, as well as the degree of severity of chronic malnutrition ($p$ = 0.015), are negatively correlated with hand washing with soap. A negative association between regular hand washing at critical times and the risk of child malnutrition has been reported [53]. For example, in Ethiopia, children with access to improved combined sanitation with handwashing facilities had a 29% lower risk of stunting than those with unimproved access. Access to improved handwashing alone reduced the risk of being underweight by 17% compared to unimproved access [54]. Poor hand hygiene practices in rural Armenia are important risk factors for stunting. Promoting handwashing during critical times reduced the risk of stunting by 14% [55]. In Pakistan, children randomized to handwashing promotion in their first 30 months achieved overall development quotients 0.4 standard deviations higher than control children [56]. However, in Guatemala, in a non-randomizedintervention involving 877 children under 5 years of age, compared to children in the control group, water quality and hand washing did not affect weight-for-age, weight-for-height, and height-for-age [57]. Similarly, handwashing alone or combined with water and sanitation in Bangladesh did not affect linear growth [58].

### 4.4. Effect of WASH on infant morbidity

The water supply sources of rivers, backwaters, and river water are, for the most part, unfit for consumption because of their level of contamination[59]. These contaminated waters can represent a strong threat to human health [36]. This is particularly the case in Sub-Saharan Africa, where water is said to be one of the main causes of disease[60]. Table VII shows the recurrence of child morbidity according to the source of drinking water consumed. It appears that children consuming river water tended to be sick more often than those consuming groundwater (p = 0.025). Diarrhea and acute respiratory infections and coughs constitute both main causes of morbidity among the children surveyed.

According to the WHO (1995), diarrheal diseases are responsible for the deaths of 3 million children under the age of five each year. Episodes of diarrhea in children result from an interaction between food, various infections, water quality, and sanitation [19]. In Niger, diarrhea is the third cause of infant and child mortality. It represents 21.25% of the reasons for hospital consultation in pediatric emergencies in Niamey[61]. Our results show a

significant relationship between the source of water supply and morbidity linked to diarrhea ($p$ = .0169 see table $p$ = .02)). This result confirms that the problem of diarrheal diseases in Sub-Saharan Africa is above all that of water quality and sanitation [62]. However, most endemic diarrhea is not linked to the transmission of pathogens through the water. Poor hygiene, lack of sanitation, and contaminated dietary supplements have been linked to diarrhea and the spread of harmful pathogens [63], [64]. Hygiene promotion is particularly cost-effective; washing hands with soap can reduce the frequency of diarrhea by 40%, but this requires soap and water [63], [65].

Fever in young children is generally a sign of an infectious disease, in particular malaria in Niger[66]. In the heart of the present study, no significant relationship was found between the consumption of river water and the occurrence of fever and malaria ($p$>.05). However, a significant relationship ($p$<.02) was found concerning ARI and cough. However, in relative proportion, children whose mothers use river water are half as affected by ARI and cough. Acute respiratory infections (ARI), particularly pneumonia, constitute one of the leading causes of child mortality in developing countries, including Niger in particular [67].

### 4.5. Sanitation

Latrines were present in only 28% of households surveyed. None of these households have modern (flushing) toilets. These results were consistent with those of EDSN-MICS IV Niger which reported that 73% of households nationally and 84% in rural areas do not have latrines [68]. It also appears from the national study to evaluate socio-economic and demographic indicators in Niger that around 81% of households in rural areas did not have latrines in 2015 [66]. In 2012, 2.5 billion people worldwide still lacked access to improved sanitation facilities, and around 1 billion defecate in the open [69], [70]. Around 69% of people without access to improved sanitation live in rural areas, as do 84% of people who defecate in the open [70].

According to the expert group report [71], lack of access to sanitation facilities poses a particular problem for women who, as a result, have to defecate at night in many societies. This is particularly the case in Sinder, where women and girls from households that do not have restrooms have to wait until night to go and defecate in groups in the bush. A study devoted to the slums of Kampala (Uganda) highlighted the existence of a clear link between the lack of access to correct sanitation facilities and the humiliation and violence suffered by women [72]. It has also been reported that the lack of safe, private toilets can harm girls' health and education [70].

In the rural commune of Sinder, latrines, in the households where they exist, are mainly reserved for adults, with children having to defecate in the open air. In Senegal, Faye et al. (2011) found that restrooms were available in 24% of households surveyed but were reserved in 47% of cases for adults. According to these authors, 61% of children defecated in nature, while 51% of them had latrines in their households. However, eliminating children's waste is crucial [73]. Sanitation is particularly adequate in combating worm infections. Children are the primary victims of diarrhea and other diseases linked to fecal-oral transmission [74], [75]. Chronic malnutrition correlates positively with poor hygiene and sanitation [16], [76]. Thus, the total elimination of open defecation in a village where everyone followed this practice made it possible to increase the average height of children by 0.44 of a standard deviation [77].

## 5. Conclusion

The nutritional situation of children under five years old is worrying, with a high prevalence of global acute malnutrition, stunted growth and underweight. Mothers do not have access to safe drinking water and use water from the Niger River, most often without any treatment. Mothers' knowledge of WASH and WASH practices is patchy and suboptimal, and they are entirely unaware of the health benefits of good WASH practices. In terms of sanitation, less than a third have traditional latrines, and open defecation is practiced by more than two-thirds of the populationa situation which exposes children under five to several diseases, especially diarrhea.

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