Water, Sanitation, and Hygiene (WASH) and the Incidence and Prevalence of Children in Five Public Primary Schools in N'Zerekore, Guinea

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Research article

Keywords: Water, Hygiene, Sanitation, Primary School Pupils, Incidence and Prevalence

Posted Date: August 28th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-53535/v1

Abstract

Background: In Guinea, the incidence and prevalence of children in public primary schools to common disease, e.g., diarrhoeal, malaria, fever, etc. remained pretty high mainly because of the poor water, sanitation, and hygiene (WASH) conditions and practices. We aimed to evaluate the impacts of WASH conditions in and out of school, health education programs, and the behavioral determinants of pupils on the incidence and prevalence of children.

Methods: A questionnaire was designed to collect necessary information on current hygiene conditions of all the studied primary schools, the WASH practices in and out of schools, and the incidence and prevalence of these pupils. The data were collected via a survey of the pupils (n = 1048) from five public primary schools in the center of the city of N'Zerekore, Guinea between December 2018 and May 2019. Using a social survey (questionnaire survey), face-to-face interviews with the headmasters and the teachers of several selected schools, data collection was based on students' knowledge of hygiene practices associated with WASH, hand washing situations in and out of school.

Results: It reveals that the WASH conditions in all five schools are inadequate. The water access and quality in four schools over all the five schools are greatly limited by the boreholes or unprotected dug wells. The scarcity of essential hygiene kits, especially in the latrines, disinclined the pupils to use the toilets in schools. The WASH and health educations are also invalid in all schools, and therefore the pupils were ineffectively influenced to change their unhealthy WASH behaviors. Our data indicated that 100% (n = 1048) of pupils don't wash their hands with soap after defecation in school, and over 87.9% (n = 922) of students don't wash hands before eating. All the above determinants result in a high incidence and prevalence of children among these pupils, including malaria, typhoid, diarrhea, etc.

Conclusion: To improve the WASH conditions and to change the pupils' unhealthy behaviors in the long term, some effective interventions including the provision of clean water and sanitation and hygiene infrastructure, as well as widespread and effective health education should be implemented.

Background

The burden of disease from inadequate drinking water, sanitation, and hygiene behaviors (WASH) remains a big challenge adversely impacting the health, education, welfare, and productivity of populations, particularly in low-income (i.e., developing) nations [1–4]. Significant efforts and progress have been made in combating the diseases derived from inadequate access to safe WASH conditions [5, 6]. However, diarrhea and relevant diseases such as cholera and typhus are still responsible for 10% of all childhood deaths on a global scale in 2010 [7]. For instance, diarrheal-related deaths of teenagers were reported to be among the top ten for the age group of 10-19-year-old and the second among the age group of 10-14-year-old on a global scale. Besides, malaria diseases account for over 40% of global health problems with varying degrees of risk in over 100 countries in Africa, Central America, and South America [8].

Specifically, primary school learners (i.e., pupils) in developing countries are among the most vulnerable population to such diseases [9–11], with reported cases of deaths ranging from 2 – 3 million per year from diarrhea-related diseases, many of which could be avoided by enhancing the WASH practices. In Africa, approximately 10,000 people perish daily from water and sanitation-related diseases, with thousands more suffering from varying incapacitating disorders [12]. It is no doubt that primary schools play an integral role in the development of children and the shaping of their behaviors by offering a platform for the acquisition of core skills, knowledge, and experience. On the other hand, clean water, lavatory facilities, and hygienic environment in schools are essential for the healthy growth of children [11, 13]. The lack of basic sanitation facilities, essential sanitary disposal of human waste, and effective hygiene education in public schools will consequently increase the incidence and prevalence of students through hygiene-related disease exposure, and possible pathogen transmission, and thus affect the pupils' learning in schools [14]. Enhanced hygiene and personal sanitation practices are of great impotence for minimizing the risks of increasing communicable diseases and improving public health [9]. PA Jumaa [15] has highlighted the importance of hand-washing using soap which could reduce cases of waterborne infections among school-going children by an average of 30%. However, millions of people have still been lacking in soap and clean water for hand-washing that would have otherwise averted the spread of disease [16].

Improving WASH practice in learning institutions can significantly improve the living standards of pupils and drive behavior shaping throughout their educational life [11, 17]. Furthermore, health and educational benefits of satisfactory school WASH access can improve learning abilities and interactions, thus providing a platform for imparting best practices and raising healthy behaviors [10, 18]. Guinea ranks the 32nd position among the African nations based on the Sustainable Development Goal (SDG) 6 composite indices which depict poor living conditions in terms of water, hygiene, and sanitation access [19]. This implies that the country is far from the acceptable level of water, hygiene, and sanitation mainly due to the deficiency of accessible toilets. Consequently, fecal wastes were discharged directly to the water bodies. Particularly, the disposal of children's feces is more likely to be a source of pollution as compared to the household environment [20]. The resultant impact is the continuous increase in contagious diseases and the low life quality of residents [21].

This study presents an exploratory analysis study of WASH conditions, including water supply and quality, waste management, and sanitation, hygiene practice, and health education within five public primary schools in N'Zerekore, Guinea. Surveys of both the faculties and the pupils in these schools provide information on the knowledge, attitudes, perceptions, practices, and experiences of the pupils towards WASH and the incidence and prevalence of the most common illnesses. The association of the poor WASH conditions and the high incidence and prevalence of children in these schools indicates an urgent need for school-level WASH intervention trials and continuous improvements in the basic WASH conditions for reduction of the incidence and prevalence of common illnesses among young children and thus the disease burden.

Methods

Location of Study

N'Zerekore is the second-largest city in Guinea and the largest city in the Guinea forestry region of southeastern Guinea. The study was conducted over the period from December 2018 to May 2019 in five public primary schools in the N'Zerekore center. These public primary schools are as follows: Mamadou Konate (**MK**), Mohomou (**Mh**), Gbanhana (**Gh**), Tilépoulou (**TL**), and N'zegbela Tokpa (**N'ZT**) (Fig. 1).

Data management and analysis

A questionnaire was predesigned to i) identify hygiene problems in each primary school, ii) improve health and educational outcomes for learners, iii) set up a hygiene committee in each school, iv) train, and operationalize the established committees, and v) make recommendations to the authorities. The survey sheets were delivered to the pupils to collect information on the WASH conditions in these primary schools.

A mixed research approach was adopted in this study. The primary data were collected by a face-to-face social survey of the pupils of grades 3 – 6 from these schools. Individual interviews with the headmasters and the teachers of several selected schools were also performed to verify the authenticity of the data from the pupils. Data collection was based on students' knowledge of hygiene practices associated with WASH, hand washing situations at school, and after school. Our questionnaire includes the following sections: i) general information of the institutions (6 questions), ii) drinking water supply (10 questions), iii) waste management (4 questions), iv) sanitary conditions of toilets (9 questions), v) personal health protection (18 questions), vi) hand-washing practice, and (vii) total sanitation situation of the school. Data were analyzed by using OriginLab Origin v9.0 software and Microsoft Excel 2010.

Results

Socio-demographic profile

The sampling numbers (*n*) are 179, 257, 142, 142, and 328 for **MK, Mh, Gh, TL**, and **N'ZT**, respectively. A total of 1048 pupils (~ 20% of the total enrollment of all schools) were sampled and interviewed from the five public primary schools, of which there were 45% girls (*n* = 471) whose age varies between 9 and 15 years old. The detailed information of sampling is listed in Table 1.

Table 1. Information on the five public primary schools and the samplings.

School name	year established	number of classrooms	school capacity	current enrollment	overcapacity	pupils sampled	girls sampled
MK	1917	13	650	896	246	179	81
Mh	1963	24	1200	1284	84	257	115
Gh	2000	9	450	712	262	142	64
TL	1992	13	650	711	61	142	64
N'ZT	1960	14	700	1640	940	328	147
Total		73	3650	5243	1593	1048	471

Water availability and quality in schools

According to our observations during the surveys, the most common sources of drinking water in the selected schools were originated from the on-campus boreholes by hand-pumping. There are three primary schools (i.e., **Mh**, **Gh**, and **N'ZT**) used such boreholes as their only drinking water sources, and the main problem associated with the boreholes was the frequent breakdown of the hand pumps as reported by the school headmasters. One of the five primary schools, i.e., **MK** obtained the drinking water from a local water company (i.e., SEG), who distributed the water to **MK** by water transporting vehicles once or twice a week. **TL** usually drew water from an unprotected dug well within the school and used it as drinking water.

Water quality surveys were also carried out in the five schools and the results are given in Table 2. The percentages of the surveyed pupils who have no doubts about the water quality of the borehole and/or well water account for 88.8%, 80.9%, 62.7%, and 62.5% for **MK**, **Gh**, **TL**, and **N'ZT**, respectively. Our survey indicates that the majority of these students who appreciated the water quality made their choices mainly in terms of the clarity of the water, i.e., if the water is clear and then it is drinkable. However, most pupils (73.9%) in **Mh** claimed that they have no opinion because they used to bring their drinking waters with portable bottles from a borehole near the school rather than the on-campus boreholes.

Table 2. Survey data on water quality, garbage disposal, latrine use,

School name		MK	Mh	Gh	TL	N'ZT
water quality survey (%)	no option	10.1	73.9	15.5	21.8	14.6
	drinkable	88.8	26.1	80.9	62.7	62.5
	undrinkable	1.1	0.0	3.5	15.5	22.9
garbage disposal survey (%)	trash bins (TBs)	75.4	54.1	14.1	41.5	90.5
	anywhere (AW)	24.6	45.9	85.9	58.5	9.5
	ratio of TBs : AW	3.1	1.2	0.2	0.7	9.5
whether or not using water in latrines? (%)	yes (Y)	63.1	28.0	38.1	16.9	54.9
	no (N)	36.9	72.0	61.9	83.1	45.1
	ratio of Y : N	1.7	0.4	0.6	0.2	1.2

Waste management and sanitation in schools

Waste management and sanitation situations in these schools were investigated by surveying and on-site inspection. In all the five schools, there were many trash bins (TBs) sponsored by some local Non-Governmental Organizations (NGOs) working for other international organizations for the protection of children such as the United Nations International Children's Emergency Fund (UNICEF). Unfortunately, many pupils are used to delivering their trash anywhere (AW) in schools rather than discarding them into the bins (Table 2). Some pupils complained that there were no trash bins in their classrooms and that is why they are used to discarding their trash everywhere. As shown in Table 2, the percentages of pupils who discarded the garbage into trash bins and anywhere vary apparently from school to school, and the ratio of TBs : AW also changes in the range of 0.2–9.5.

Waste management systems such as garbage clearance and transporting systems for further treatment or recycling have not been established in all the five schools yet. The most widely used waste/garbage management method in these schools, as claimed by the pupils, was incineration in the open air without the use of any type of equipment such as an incinerator with an acidic or alkaline scrubber. This will instantly pollute the local atmospheric environment and cause breathing disorders (e.g., coughs), vision problems (e.g., transient blindness by polluted smokes), and even learning disorders, especially to the onlooking students. Indeed, our survey found that an average of 22.9% (n = 248) of pupils surveyed was suffering greatly from respiratory diseases (Fig. 2). Furthermore, although Saturday is the day for school sanitation in the city of N'Zerekore as recommended by the Director of Prefectural Education (DPE), this regulation has not been well implemented yet by some schools. Some students, for example, claimed that they just swept the classrooms and picked up the garbage on campus without the use of any detergents and disinfectors on Saturdays.

Hygiene practices in schools

It was worthy to note that none of any surveyed primary schools have access to healthy hygiene practices due to the scarcity of essential hygiene kits especially in the latrines, e.g., toilet rolls, water, and soaps, etc (Fig. 3). As shown in Fig. 3, the latrines did exist in all the primary schools surveyed, but the state of their insalubrity was notable. A survey on whether or not using water for personal hygiene and/or feces clean-up after toilet use shows that most pupils in **Mh**, **Gh**, and **TL** did not use water because of the unavailability of water in the latrines (Table 2). In **TL**, for example, 83.1% of pupils interviewed said that they did not use water in the latrines as there was no water. However, some students who gave a positive response to this issue claimed that they used to draw water from the on-campus boreholes or the nearby residents for hand-washing after the toilet use. A surprising fact is that some pupils did not recognize the existence of latrines in their schools.

Furthermore, our survey of a total of 1048 pupils reveals that the hand hygiene behaviors of pupils in all the five primary schools were especially alarming (Table 3). The results show that 100% of pupils were not used to washing their hands with soap after using the toilet, 87.9% were not accustomed to washing before eating; 90.8% were not conditioned to washing after eating, and 94.4% were not habituated to washing after playing (Table 3). Most of the pupils were not likely to wash their hands at the key moments for hand hygiene in schools mainly due to the scarcity of both water and soap in schools and the ignorance of the importance of hand hygiene in personal and health care as claimed by the majority of pupils surveyed.

Table 3. Survey on key moments for hand hygiene in and after school

key moments for hand hygiene	in school (%)		after school (%)	
	yes	no	yes	no
after using the toilet	0.0	100.0	69.5	30.5
before eating	12.1	87.9	99.7	0.3
after eating	9.2	90.8	81.7	18.3
after playing	5.5	94.6	55.2	44.8

WASH and health education in schools

Our survey also found that WASH and health education are ineffective in all five schools. As declared by the teachers in the surveyed schools, they have run lessons on hygiene practices with relevant topics such as school hygiene, domestic hygiene, and environmental pollution. However, the majority of pupils are not likely to perform as taught in the course in their own lives. The overall outcomes of WASH education are pretty low in all surveyed schools. Therefore, the percentage of pupils involved in diseases such as diarrhea, eye diseases, fever, headache, malaria, respiratory disorders, skin diseases, and typhoid remained high above the world average level (Fig. 2).

Our study has established a fact sheet of the common diseases among the pupils in these schools. The survey results show that an average of 67.9% (*n* = 719) of the surveyed students often suffered from malaria, 74.7% (*n* = 761) often involved in typhoid, 71.7% (*n* = 798) of diarrhea, 76.0% (*n* = 825) of fever, 22.9% (*n* = 248) of respiratory diseases, and 32.0% (*n* = 310) often suffered from skin diseases (Fig. 2).

WASH practices after school

The WASH practices of the pupils after school (i.e., at home) were also assessed about the drinking water source, key hand-washing moment, and household waste management. As shown in Fig. 4, the primary drinking water sources at the pupils' homes vary from school to school. Tap water (from both public taps and piped water) and well water from either dug wells or boreholes are the two main drinking water sources among all the pupils' homes. For instance, tap water as the main drinking water sources at home accounts for 53.1%, 37.1%, 51.4%, 33.8%, and 37.8%, respectively for pupils in **MK**, **Mh**, **Gh**, **TL**, and **N'ZT**. Whereas, 31.2% of pupils in **MK**, 26.4% of pupils in **Mh**, 36.6% of pupils in **Gh**, 58.4% of pupils in **TL**, and 38.1% of pupils in **N'ZT** obtained their drinking water from either borehole or dug wells nearby their homes. Note that 34.6% of students in **Mh** and 21.3% of pupils in **N'TK** claimed that they cannot get drinking water from home but borrow drinking water from their neighbors.

As shown in Table 3, the hand hygiene of the surveyed pupils at home (or after school) has been improved greatly as compared with that in school. Approximately 99.7% of the studied pupils used to wash their hands before eating, 81.7% after eating, 55.2% after playing, and 69.5% of these pupils were used to wash their hands with soap after defecating (Table 3). This improvement in hand hygiene of pupils at home was mainly attributed to the supervision from parents or other family members, who will force these students to wash their hands with soap after defecating, playing, before and after dinner.

Household waste management data show that 45.2% of pupils in **MK**, 60.3% in **Mh**, 83.8% in **Gh**, 65.5% in **TL**, and 64.6% in **N'ZT** have no trash bins in their homes. The deficiency of trash bins in the pupils' home of the primary schools is attributed to the fact that they lived in the center of the administrative district where is near to the biggest market of the city of N'Zerekore. The local NGOs and the town council usually conduct clean-up exercises in these areas.

Discussion

Summary of main results

Due to the overpopulation and the shortage of teachers, all the five primary schools were overloaded with a total overloading rate of 143.6% (Table 1). The overpopulation has led to large intakes in schools. For instance, there was an excess of 940 students in **N'ZT** school (Table 1). This situation facilitates the transmission of diseases and leads to the risk of the spread of infectious diseases. Overpopulation and urbanization have led to the spread of diseases among people who live nearby [22].

The water access and quality varied from school to school, and only three schools, namely, **Mh**, **Gh**, and **N'ZT** can meet the SDG-6 standards to some degree for the safe management of the drinking water from

the on-campus boreholes. However, they used to experience serious water shortages in arid seasons when the wells dried up.

The waste management (e.g., access to the trash can, garbage collection, and disposal on campus), sanitation access (e.g., access to hand-washing kits with soap and water, access to latrines with water, latrine maintenance, and fecal sludge management), and hygiene practices (e.g., handwashing before eating and after defecation, soap use) in schools were not sufficiently implemented (Tables 2 and 3), which in turn led to a higher incidence and prevalence of child in all the primary schools (Fig. 2).

The need for proper WASH interventions

There are a variety of studies that have reported the results of interventions to reduce illness through improvements in drinking water, sanitation facilities, and hygiene practices in less developed countries [23-34]. The WASH interventions as classified by Fewtrell and co-workers [2] should include but are not limited to water supply interventions (e.g., the provision of new or improved water supply or improved distribution at either the public level or household level), water quality interventions (e.g., the provision of water treatment for the removal of common contaminants, either at the source or at the household level), sanitation interventions (e.g., improved means of excreta disposal, improved management of domestic waste), hygiene interventions (e.g., hygiene and health education and the encouragement of specific behaviors, such as hand-washing, advice on the correct disposal of human feces, measures for keeping animals out of the kitchen), and multiple interventions (e.g., any combination of the water, sanitation, and hygiene (or health education) interventions).

Our survey data indicate that the illnesses found in the children from all five primary schools include cholera, diarrhea, eye diseases (e.g., trachoma, pinkeye), fever, headache, malaria, skin diseases, and typhoid (Fig. 2). All of these illnesses can be reduced or eliminated by appropriate WASH interventions. For example, the levels of diarrheal illness can be significantly reduced by the water supply and treatment interventions, with the greatest impact from the hygiene and household water treatment interventions [35]. It is also found that some specific WASH interventions such as daily facial cleanliness, and sanitation access, as well as environmental improvement, can prominently reduce the prevalence of trachoma [29]. A recent study has shown that interventions in five general WASH factors (i.e., water treatment, water source/supply, sanitation, hand hygiene, and water storage), including boiling of water, using rainwater as a source, improving sanitation, hand-washing after defecation with soap, and using a narrow-mouthed container for water storage can lower the odds for cholera transmission [36].

Different interventions may play different or alike roles to reduce the odds of some diseases, and multiple interventions would likely be more effective than a single one. However, for a specific disease, e.g., diarrhea, it has been demonstrated that water quality interventions such as point-of-use water treatment would be more efficient than multiple WASH interventions [2]. Therefore, it is crucial and urgent to conduct a WASH intervention trial in these primary schools focusing on what the exact intervention would be the most efficient for lowering the odds for the most common illnesses of their students. A specific proper WASH strategy for each primary school is based on the main results of the above WASH intervention trial. In other

words, the knowledge gap of which interventions are the most appropriate for a given context (e.g., the specific WASH conditions of the surveyed primary schools) needs to be filled by evaluating the impacts of a variety of WASH interventions, ensuring effective disease control and the best use of limited resources. According to our survey, improving the water source and quality, and providing the essential excreta disposal facilities are likely to be among the most efficient interventions for the control of waterborne diseases among the children.

Policy implications

Worldwide, there has been considerable progress in global access to improved WASH conditions including safe drinking water supply, enhanced excreta disposal facilities, and good hygiene and health educations, specifically in East and South Asia [29]. However, there is also a large population in Africa, where the primary student's incidence and prevalence remain pretty high due to the poor WASH conditions. For example, less than 50% of households have access to an improved sanitation facility, and more than 25% of households practice open defecation in sub-Saharan Africa [37]. Our survey found that all the five primary schools were far from enough to meet the SDG/WHO/UNICEF standards for basic sanitation services, i.e., learning institutions must have a handwashing facility with water and detergent. Despite the efforts of WHO/UNICEF and other NGOs during and after the Ebola virus outbreak, these public primary schools were still suffering from the lack of funding for the supply of handwashing facilities, soap, and chlorine. Although the deficiency of soaps or hand-washing facilities at schools in developing countries like western Kenya remains one of the leading challenges, more importantly, the hygiene and health education towards changing the children's hygiene behaviors is another foremost challenge [38].

This study established the association between the WASH conditions in five public primary schools (including water sources, water quality, waste management and sanitation, student's hygiene practices in schools, WASH and health education, and WASH condition and practice out of schools) and the incidence and prevalence of the most common illnesses among these students. Our data support the signification of school-based WASH promotion including improved WASH conditions as well as health and hygiene education to reduce the odds of the most common illnesses among these students. Controlling such diseases in developing countries would have a considerable positive impact on the physical and mental health of the children, therefore there should be more emphasis on expanding investment in improved school-level WASH conditions, health education, and hygiene practices as an important part of development guidelines and targets. Improved water supply and quality, adequate sanitation facilities, health education, and hygienic practices are all important and intertwined interventions for the reduction of the incidence and prevalence of common illnesses among these students. Our study emphasizes the need for school-level WASH intervention trials to elucidate what package of specific interventions will maximize the health benefits to each school and ensure the best use of limited resources [35], and the need for context-specific research, as identified by geographic variations in disease prevalence [39]. The results will help policy experts make decisions to formulate effective policies, e.g., school-based WASH promotion policies, which will facilitate to lower the incidence and prevalence of common illnesses among young children and thus the disease burden.

Conclusion

A learning institution must have the basic sanitation facilities including adequate water supply with acceptable quality, sanitation facilities, e.g., handwashing kits to protect learners and teachers against diseases, and the students deserve to learn in healthy environments with access to acceptable WASH facilities. However, the WASH conditions in five primary public schools were really poor, which significantly contributed to their high incidence and prevalence of the most common illnesses among the children. Consequently, school-level WASH intervention trials are needed to elucidate what package of specific interventions will maximize the health benefits to each school and ensure the best use of limited resources. Constructive policies must be initiated at all levels from the national to the district, and the locality and then to the school to encourage and facilitate the establishment of adequate distribution facilities for water, hygiene, and sanitation in schools. An appropriate policy framework should enable stakeholders to put in place effective governance and management arrangements for planning, financing, implementation, and coordination of interventions aimed at improving the health situation within the school environment, and thus lowing the disease burden of the children.

Abbreviations

AW: Anywhere; DPE: Director of Prefectural Education; Gh: Gbanhana; Mh: Mohomou; MK: Mamadou Konate; NGOs: Non-Governmental Organisations; N'ZT: N'zegbela Tokpa; SDG: Sustainable Development Goal; TBs: Trash Bins; TL: Tilépoulou; UNICEF: United Nations International Children's Emergency Fund; WASH: Water, Sanitation, and Hygiene; WHO: World Health Organisation

Declarations

Ethics approval and consent to participate

The study was ethically approved by both the NUIST School of Environmental Science and Engineering's ethical review committee and the University of N'Zerekore's ethical review committee. Verbal consent was obtained from all participants and/or their parents/guardians of the students.

Consent to publish

Not applicable.

Availability of data and materials

Datasets can be obtained by contacting the corresponding authors on reasonable request.

Competing interests

The authors declare no conflict of interest.

Funding

No funding was obtained for this study.

Authors' Contributions

AB1 conceived of the study design, conducted data collection and analysis, and wrote the first draft of the manuscript. AD and AB2 contributed to data collection. FL analyzed the data, wrote the first draft of the manuscript. All authors read and approved the final version of the paper before submission.

Acknowledgments

We thank the study participants (i.e., all the surveyed students and faculties in the five public primary schools) and the University of N'ZEREKORE for their support with the implementation of this study. Alseny Bah thanks the Chinese Government Scholarship (2018DFH009080) for supporting his Master's degree program in NUIST.

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Figures

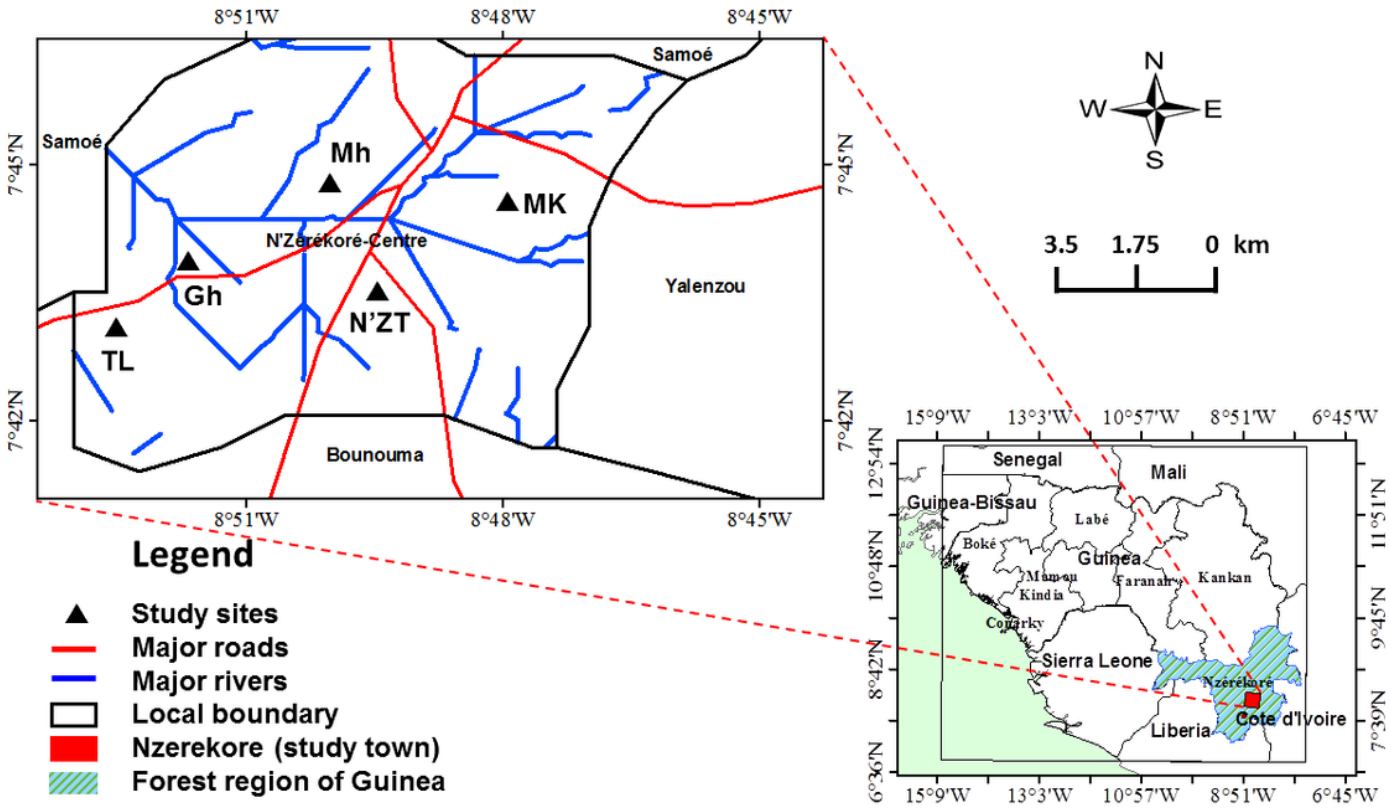

Figure 1

Map of the study sites.

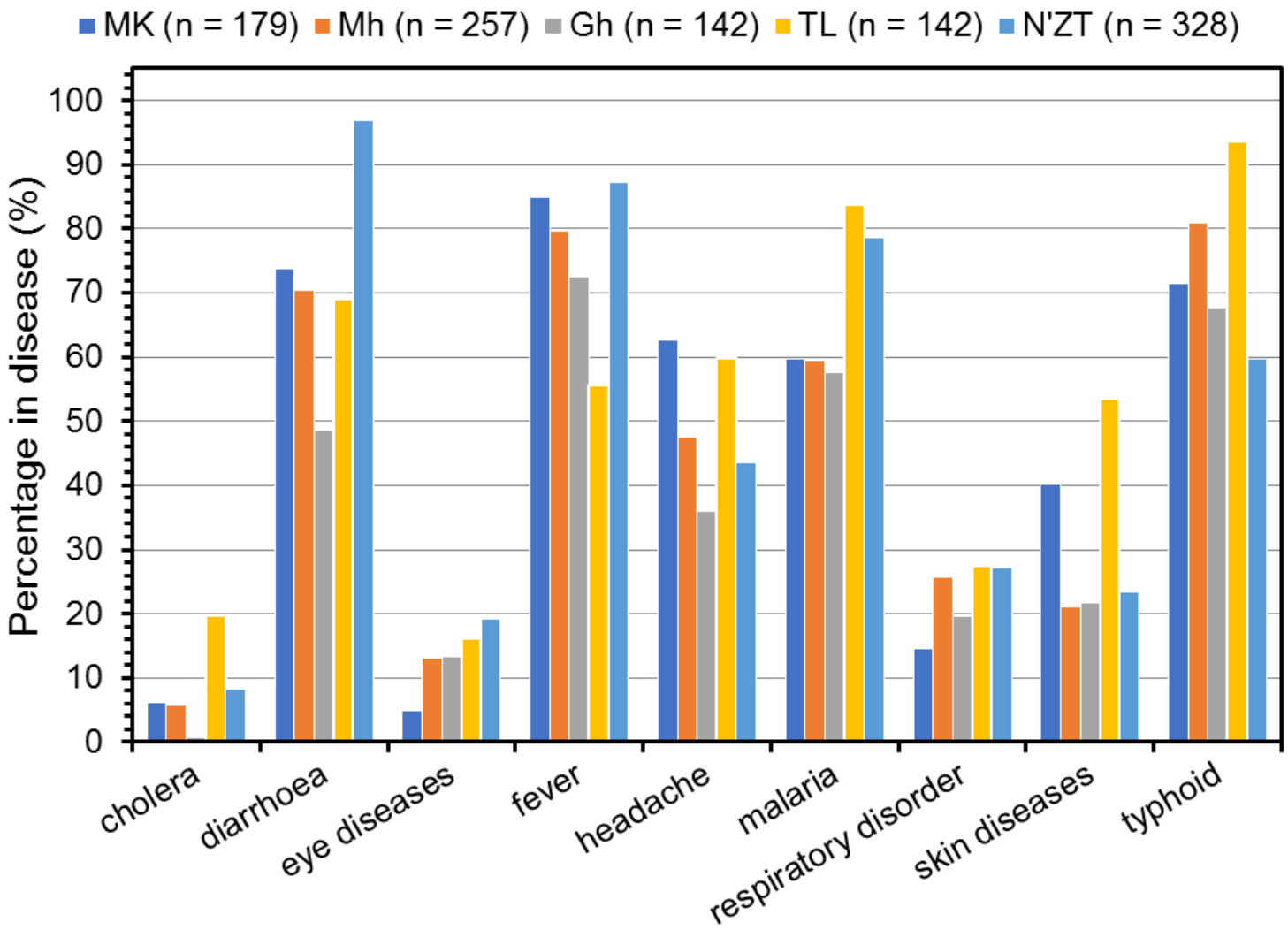

Figure 2

Percentage of surveyed pupils involved in disease

Figure 3

Some unsanitary toilets and garbage dump in schools: a) MK, b) Mh, c) TL, and d) N'ZT.

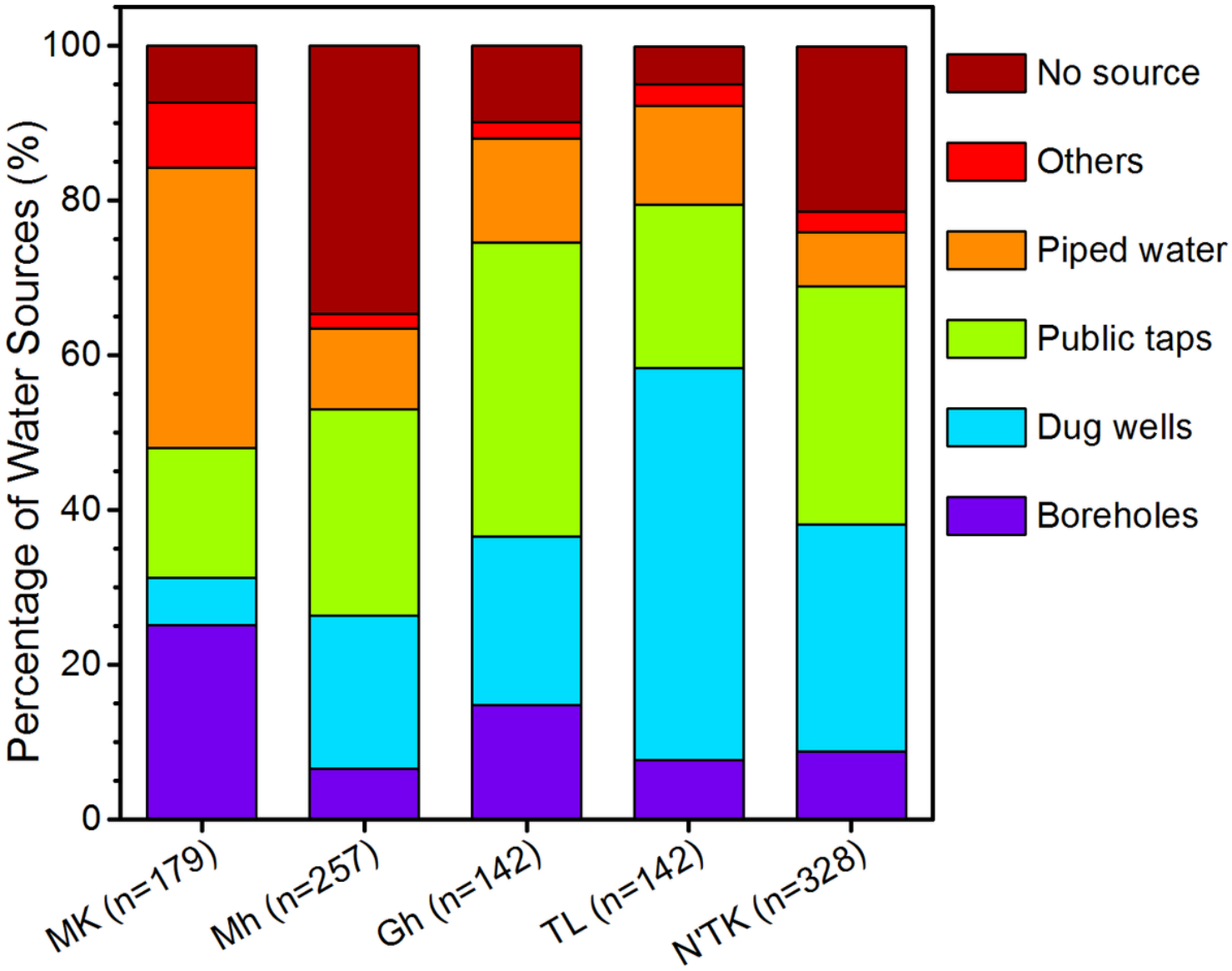

Figure 4

Primary drinking water sources at pupils' homes.

Supplementary Files

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- QuestionnaireonWASH.docx