RESEARCH ARTICLE

The status of water access, sanitation, and hygiene in schools: A cross sectional survey to identify capacities and assess coverage in Garoua, North Cameroon

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Abstract

There has been an increasing global interest in understanding, documenting, and monitoring water, sanitation, and hygiene (WASH) services in schools. This study is the first to identify existing WASH-in-school capacities and understand the magnitude of the gaps in WASH coverage in schools in the Northern Cameroon, a region of the country marked by recurrent sanitary emergencies, the highest prevalence of acute malnutrition, and representing the largest and heaviest focus of food and water insecurity. Using a cross-sectional design, relevant authorities of 176 schools in Garoua, were interviewed. The survey guide included core questions for monitoring WASH in schools from recommended guidelines. Eleven indicators-related variables were extracted from data to calculate the WASH-in-school indicators composite score, which could be used as a more reliable and useful tool for comparison across settings and can contribute to harmonize data with WASH in schools related indicators applied in national surveys. The results of this research showed suboptimal drinking water supply systems and sanitation facilities whereas most schools had hand washing points available. However, activities that aimed to promote and sustain a WASH positive environment among children still need to be put in place. The WASH-in-school indicators composite score predictive value corroborated the disparities related to WASH access in schools located in Garoua. This score hence provides an assessment of the spatial dimensions of reduced access to water in schools, improper hygiene practices, and inadequate sanitation facilities. Such a score could be used to identify hotspots lacking WASH
infrastructural facilities and strategize optimal interventions to reduce the incidence of WASH related diseases in schools.

Introduction

The World Health Organization (WHO)/United Nations Children’s Fund (UNICEF) Joint Monitoring Program (JMP) defines clean water as one fetched from an improved source i.e., a source, which by the nature of its construction, is adequately protected from outside fecal contamination [1]. Following the International Framework of Human Rights, the right to water and sanitation is the responsibility of states and non-state actors and is essential to fulfill the rights to the highest attainable standard of health as well as the rights to adequate housing and foods [2]. But currently, 771 million people still lack access to basic drinking water services (improved source + water collection time ≤ 30 minutes) with half of them living in sub-Saharan Africa [1]. Additionally, 1.7 billion people lack basic sanitation services with 494 million people among them, practicing open defecation. Further, 670 million people have no hand washing facilities and more than half of them live in fragile contexts [1]. Unfortunately, the drawbacks of this scarcity of water, sanitation, and hygiene (WASH) services in underserved communities of sub-Saharan Africa, go beyond the household setting to other public places, essential for human socialization such as schools, markets, bus stations, religious facilities and refugee camps, significantly impacting the populace’s health, welfare, and productivity [3]. The 2030 sustainable development goals (SDG) have included multiple targets and indicators seeking universal WASH access not only to households setting but also to schools, followed by an increasing global interest in understanding, documenting, and monitoring WASH services in schools [4].

By definition, WASH in schools refers to a combination of: technical components i.e., drinking water, handwashing and toilet facilities in and around the school and human development component, which includes activities promoting both the conditions within the school and the practices led by children to prevent water and sanitation-related diseases [5]. The lack of WASH facilities and/or poor hygiene and sanitation practices at schools, coupled with the decrease immunity secondary to a complex interaction between food-and-water insecurity and undernutrition, result in adverse health outcomes in students; including dehydration due to low water intake (children refraining from drinking), bladder issues following voluntary urine retention, as well as infectious and gastrointestinal illnesses. For instance, the results of a comparative cross-sectional study in Ethiopia identified a high prevalence of diarrhea (21.9% higher) among children from non-WASH-implementing schools compared to their counterparts [6]. In addition to that, poor WASH-in-school access leads to low educational outcomes by contributing to low enrollment rates, high absenteeism, insufficient attention in class, and reduced classroom performance [7]. When focusing on girls requiring facilities for personal hygiene, results of studies support a relationship between WASH and decline in school attendance [8]. Furthermore, menstruation-related barriers such as inadequate health education about menstruation, lack of support for managing menses in school, and insufficient menstruation pads disposal infrastructures result in missed hours or days of school as well as anxiety around potential menstrual accidents among females [9].

Besides, poor WASH access impacts disease transmission among children and has weakened the WHO efforts to eradicate soil-transmitted helminthiasis by favoring reinfections despite regular deworming of children in schools [10]. Teaching hygiene behavior among school age children has been shown to be the most successful when the focus is on a limited number of behaviors with the biggest overall health impact, such as the ones included in the F-digram. The F-digram highlights the paths by which pathogens can spread from person to person.
person as a cycle characterized by five F’s (Fluids—the drinking of contaminated water, Fields—the contamination of soil, crops, or fruits by human excreta, Fingers—fecal contamination of fingers/hands, Food—eating food contaminated with fecal matter, and Flies—which spread diseases from feces to water and food) [11, 12]. However, to achieve optimal WASH practices and intervene at critical stages of cross-contamination as pictured by the F-Diagram to completely stop fecal-oral transmission and reduce the incidence of diarrheal diseases and nutrient malabsorption is extremely difficult in a context, where about 31%, 37%, and 43% of schools lack access to basic water, sanitation, and hygiene services respectively [13, 14]. Especially, educating children on WASH in schools increases their potential to act as agents of change in their households and communities and influence the hygiene practices of their parents and siblings [15]. The results of studies in Kenya and Ethiopia reported significant increments in parents’ WASH-related knowledge and practices endline vs. baseline after a school-based WASH intervention, highlighting the fact that behaviors learned at schools were transferred by children to their households members [16, 17].

In practice, the comprehensive analysis of the magnitude of the gaps in coverage of WASH in schools in sub-Saharan Africa countries is relatively poor, even though available data show low estimates [18]. The 2022 JMP Cameroon National report included data mainly for water access in primary school level, with 43% of schools with no water service and 37% with basic water service. No data was available for any WASH services at the secondary school level as well as no hygiene-related data were reported [13]. Acknowledging health and educational benefits of WASH-related infrastructures and practices, and most importantly throughout the COVID-19 pandemic, the JMP has recommended frequent monitoring of the key WASH-in-schools indicators. This will enable governmental and multilateral agencies to identify areas in need to be addressed, track specific objectives and focus resources and interventions to improve WASH coverage [4]. Emphasis should therefore be put on schools serving communities that statistics related to undernutrition among children and/or food insecurity are the highest [19]. This study is of significant interest because it will provide policymakers, regulatory agencies, and management authorities with baseline information that would serve to advise for planning and interventions in areas with the greatest needs for improved WASH services in order to improve personal hygiene and environmental sanitation within the school setting. Hence, in order to identify existing WASH-in-school capacities and understand the magnitude of the gaps in WASH coverage in schools in Cameroon, this study aimed to:

1. Describe WASH access (number and type of water sources), continuity (availability without interruption), quality (improved/unimproved), and coverage (proportion of schools meeting basic access criteria for each indicator) in schools in Garoua, North Cameroon;

2. Investigate the contribution of some factors on school WASH, namely (i) level of education facility (preprimary, primary and secondary); (ii) type of ownership (public, private/commercial, faith-based); and (iii) geographic situation (Garoua subdivisions);

3. Develop a composite score for WASH services in schools and assess its ability to accurately reflect the level of WASH Services as deduced from the application of the eleven indicators used by the JMP.

**Methods**

**Study area**

Cameroon is a low-income country from sub-Saharan Africa. It is administratively divided into ten regions, including the North region, which makes up 66,090 km² of the northern half
of the country [20]. The North region is bordered by the Adamawa region to the south, Chad and Central African Republic to the East, Nigeria to the west, and the Far North region to the North. The North region climate is of sudano_sahelian type, with a dry season of nine months and a rainy season lasting three months. The mean annual temperature is 34.9˚C and the average annual rainfall is 1800 mm [20–22]. The rivers in the North region experience high water regime during the rainy season when flooding may occur and mostly dry up during the dry season [20]. On the administrative plan, the North region is divided into four departments (Benoue, Faro, Mayo-Louti, and Mayo-Rey). The Benoue division, which sheltered the study area includes 12 sub-divisions, especially Garoua 1, Garoua 2, and Garoua 3, where the study took place [20–22].

The study was conducted in the capital city of the North region, Garoua, which has a total population estimated at 900,000 inhabitants in 2018 and is a thriving center of the cotton industry with multiple textile processing factories. Garoua I, II, and III sub-divisions constitutes the Garoua urban community. The “Boko Haram” war in the neighboring Far North Region and the massive influx of refugees from Central African Republic have impaired many neighbor region’s large scale farmers’ business and brought in thousands of refugees in the North region, leading to increased levels of food insecurity and subsequent children undernutrition over the recent years [23, 24].

According to the education law N°98/004 of April 14th 1998, the non-higher education system in Cameroon comprises the pre-primary (4–5 years old), primary (6–11 years old), and secondary levels (12–18 years old) and the school programs are about 6–8 hours from Monday to Friday. In 2019, the Cameroon school age population was estimated at 9,704,000 with 16%, 43%, and 41% being from the pre-primary, primary, and secondary levels respectively [13]. Even though one of the highest women (49%) and men (27%) illiteracy rates is found in the North region, the school enrolment rate is around 70% for primary level and 23% for the secondary level. In the city of Garoua, there is a total of 270 private and public schools distributed as follows: 153 in Garoua 1, 71 in Garoua 2, and 46 in Garoua 3.

**Study population and design**

Following the JMP guidelines, all schools with preprimary-level, primary-level, and secondary-level students were counted as pre-primary, primary, and secondary schools respectively; meaning some schools could have been double-counted and the total number of schools might not necessarily correspond to the sum of the pre-primary, primary and secondary schools in the study area. As a first step, officers of the regional delegations of basic and secondary education of the North Region were contacted and an exhaustive list of schools obtained from them. Then, from November 2020 to July 2021 and using a cross-sectional design, invitations to participate in the study were sent to all the schools identified in the study area i.e., Garoua 1, Garoua 2, and Garoua 3 cities. The authorities of a total of 183 out of 270 schools, who responded to our invitations were met and the research explained to them. Those of the schools whose principals/directors or any other relevant authority gave consent to participate in the survey were consecutively included in the study. The study population hence consisted of those of the directors or school authorities available and willing to respond to the questionnaire.

As the data collection for the study took place amidst COVID-19 pandemic, measures were taken to reduce contamination risks during one-on-one interviews in alignment with the Cameroonian government recommendations. These included, but were not limited to washing of hands with soap and running water whenever possible when arriving and departing from each school or using of hydro alcoholic solution and the respect of social distancing.
Survey instrument

A semi-structured questionnaire served as the interviewing tool to determine WASH conditions in participating schools. The research assistant, a doctoral student, conducted one-on-one face-to-face interviews in a private setting and the interviews took place throughout the year, both in the dry and rainy seasons. The questionnaire included a first section providing basic school-related information: geographical location of schools, type of school ownership, education level of the school, number of students, and number of teachers. In the second section, indicators following international standards and adapted from the “core questions and indicators for monitoring WASH in schools in the SDG” [8] and the “Guidance note to facilitate Country consultation on JMP estimates for drinking water, Sanitation and hygiene in schools” [25] were identified and phrased into questions (Table 1). The eleven indicators respectively addressed drinking water access (water source, improved water source, improved water source with water available), sanitation (toilets facilities, improved toilets, sex-separated improved toilets, usable improved toilets, sex-separate usable improved toilets), and hygiene practices (handwashing facilities, handwashing facilities with water available, handwashing facilities with water and soap available). Even though not included as a core indicator for this research, UNICEF and WHO recommend that late primary and secondary schools must ensure not only privacy for boys and girls, but also have provision for menstrual hygiene [12]. Hence, questions aiming to assess other key hygiene behaviors for school children such as menstrual hygiene, waste management and water drainage in selected schools were included in the questionnaire (see SI Text).

Data analysis

Data analysis was conducted using IBM-SPSS version 26. We explored, structured, and represented the information contained in the data as categorical and quantitative variables. The

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Principal component</th>
<th>Score range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking water access score</td>
<td>Component 1</td>
<td>0–3</td>
</tr>
<tr>
<td>• Water source (DW1)</td>
<td>Component 1</td>
<td></td>
</tr>
<tr>
<td>• Improved water source: piped water, protected well/spring, rainwater catchment, and packaged or delivered (tank) water (DW2)</td>
<td>Component 1</td>
<td></td>
</tr>
<tr>
<td>• Improved water source with water available (DW3)</td>
<td>Component 1</td>
<td></td>
</tr>
<tr>
<td>Sanitation score</td>
<td>Component 2</td>
<td>0–5</td>
</tr>
<tr>
<td>• Toilets’ facilities (S1)</td>
<td>Component 2</td>
<td></td>
</tr>
<tr>
<td>• Improved toilets: flush/pour-flush toilets, pit latrines with slab, and composting toilets (S2)</td>
<td>Component 2</td>
<td></td>
</tr>
<tr>
<td>• Sex-separated improved toilets (S3)</td>
<td>Component 3</td>
<td></td>
</tr>
<tr>
<td>• Usable improved toilets (S4)</td>
<td>Component 2</td>
<td></td>
</tr>
<tr>
<td>• Sex-separate usable improved toilets (S5)</td>
<td>Component 3</td>
<td></td>
</tr>
<tr>
<td>General hygiene score</td>
<td>Removed from the scale</td>
<td>0–2</td>
</tr>
<tr>
<td>• Effective handwashing facilities: sink with tap, water tank with tap, bucket with tap, tippy tap, or similar device. PS: a shared bucket used for dipping hands is not considered an effective handwashing facility (GH1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Handwashing facilities with water available (GH2)</td>
<td>Component 4</td>
<td></td>
</tr>
<tr>
<td>• Handwashing facilities with water and soap available: Ash or mud may be available for hand cleansing but is not an acceptable alternative to soap (GH3)</td>
<td>Component 4</td>
<td></td>
</tr>
<tr>
<td>WASH-in-schools indicators total composite score</td>
<td></td>
<td>0–10</td>
</tr>
</tbody>
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categorical variables were analyzed according to the percentages. The quantitative variables were presented with respect to the median and interquartile range. The specification of the main indicators for access to WASH in schools was conducted by determining the proportions and/or percentages for each indicator.

The eleven indicators corresponding with the international standardized classification were computed from the data and 11 variables were generated (Table 1). With 176 school authorities responding to the questionnaire, the general thumb rule of 10:1 ratio, i.e., having at least 10 participants per scale item was verified [26]. Item reduction was conducted using non response rates and item discrimination index, which measures the extent to which respondents who answered yes to a particular statement had a high overall score. Because the variable GH1 (“effective handwashing facilities”) was constant, it was removed from the scale. Principal component analysis revealed four main components that could be grouped into three main dimensions: water access, sanitation, and general hygiene (Table 1). Hence, three variables defined the water sub-score, five variables the sanitation sub-score, and two variables assessed the effectiveness of hygiene practices. The values for each variable were rated as “present in the school” (coded 1) or “absent in the school” (coded 0), giving each variable a possible score of 0 or 1. Assuming each variable weighed equally, the WASH-in-school indicators composite score was calculated by summing the 10 variables individual scores, resulting in a total score ranging from 0 to 10, with 0 being the lowest and 10 the highest. The Cronbach’s coefficient assessed the reliability of the WASH-in-Schools composite scale.

Chi-square (or Fisher exact test if appropriate) and one way ANOVA were used to assess disparities among WASH indicators, WASH-in-school indicators composite score, and/or geographic location of schools, their education level, the schools size, as well as their type of management. The construct validity assessments were carried out to determine the predictive validity of the WASH-in-School indicators composite scale. The p value for significance was set as <0.05.

**Ethical statement**

Prior to the beginning of the study, the institutional review board of the Faculty of Medicine and Biomedical Sciences, University of Yaoundé 1, approved the study protocol (Ref. N˚ 0006/UY1/FMSB/VDRC/DAASR/CSD). Additionally, free and informed written consent was sought and obtained from the schools’ authorities, respondents of the questionnaire.

**Results**

**Schools’ characteristics**

Among the 270 schools identified in the study area, a total of 176 (65.19%) school authorities accepted to participate in the survey, corresponding to a participation rate of 54%, 91%, and 61% in Garoua 1, 2, and 3 respectively. Among the recruited schools, 45 (25.56%), 114 (64.77%), and 17 (9.65%) were from the pre-primary, primary, and secondary levels respectively (see Table 2); totalizing 77,208 students. In addition to that, one-third of the schools were privately managed with 58% of them being laic whereas 42% were confessional. The other 68.8% of schools were under the government management (Table 2).

**Description of WASH access, continuity, quality, and coverage in schools**

**Drinking water supply**

Drinking water supply services

Piped water (48.3%), followed by protected wells (45.5%) and tank water (11.4%) represented the main existing water supply systems found in the schools selected for the study.
According to the school authorities, the major drinking water sources were piped water (46.7%) followed by wells (44.4%) in pre-primary schools, wells (45.6%) followed by piped water (38.6%) in primary schools, and piped water (70.6%) followed by wells (29.4%) in secondary schools.

Despite some schools had more than one type of water source available, 18 schools (10.2%) did not have any existing drinking water supply infrastructure, corresponding to one out of ten (1:10) students, who did not have access to any source of water while in school (Table 3).

When summing up the individual water sources listed in each school, there was a total of 379 drinking water points corresponding to a median of 1 (IQR: 1–2) drinking water source per school. As for the continuity (availability without interruption of water sources) of the water source, about 64.2% of participants reported their water source has been functional during the last two weeks. On the other hand, 14.8% of schools had their water source broken down for at least 30 consecutive days throughout the year. As shown in Table 3, around half of schools (44.3%) reported practicing some sort of water treatment methods with the principal ones being chlorination (31.3%) and filtration (11.9%).

Drinking water supply coverage

As shown in Table 4, one out of five schools in the study area did not meet the criteria for basic drinking water access i.e., improved source + water available. At each of the three subdivisions of Garoua, the study area, more than three-quarter of schools met the criteria for basic drinking water access. When focusing on the type of school ownership, privately managed schools (94.5%) tended to have a higher proportion of their schools meeting the criteria for basic drinking water access, compared to public schools (73.6%), and the difference was statistically significant. At the level of the educational stage, secondary schools had the highest percentage of water access coverage followed by pre-primary schools (Table 4).
Sanitation facilities. Description of sanitation facilities. Pit latrines with slabs (86.4%) were the most common latrines facilities in schools of the study area followed by flush toilets (9.7%). Only one school reported not having any existing latrine facility and 2.8% schools used unimproved latrines. This corresponded to 295 students who were enrolled in a primary school without available toilet facilities and were highly likely to be involved in open defecation practice.

Among the 1,011 latrines facilities available in the selected schools, 105 (10.39%) were meant to be used by both genders (Table 3). While the number of students ranged from 07 to 3226 per school, the number of latrines ranged from 1–22, leading to a pupil-to-latrine ratio per school of 81:1 on average (IQR: 33–100). Moreover, when considering gender-specific student population, the results showed that the boy students-to-latrine ratio was 77:1, very high compared to the WHO norm of ideally 50 boy students per latrine. Similarly, the girl students-to-latrine ratio was 76:1, whereas the WHO recommended norm is <25 girls/latrine. Approximately 45% and 20% of schools in the study area respectively met the WHO thresholds for boys and girls.

However, as shown in Table 3, when asking about the cleaning frequency, approximately half schools did that on a daily basis and for 8.5% of them, the latrines were cleaned up one
<table>
<thead>
<tr>
<th>Indicators</th>
<th>Garoua sub-divisions</th>
<th>School ownership</th>
<th>Level of education</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Garoua 1</td>
<td>Garoua 2</td>
<td>Garoua 3</td>
<td>P value</td>
</tr>
<tr>
<td>Water source</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved water source</td>
<td>77 (85.6%)</td>
<td>59 (90.8%)</td>
<td>18 (85.7%)</td>
<td>.604</td>
</tr>
<tr>
<td>Improved source + water available</td>
<td>71 (78.9%)</td>
<td>53 (81.5%)</td>
<td>16 (76.2%)</td>
<td>.849</td>
</tr>
<tr>
<td>Toilets</td>
<td>90 (100%)</td>
<td>65 (100%)</td>
<td>20 (95.2%)</td>
<td>.024*</td>
</tr>
<tr>
<td>Improved toilets</td>
<td>88 (97.8%)</td>
<td>62 (95.4%)</td>
<td>20 (95.2%)</td>
<td>.674</td>
</tr>
<tr>
<td>Sex-separated improved toilets</td>
<td>76 (84.4%)</td>
<td>54 (83.1%)</td>
<td>19 (90.5%)</td>
<td>.713</td>
</tr>
<tr>
<td>Usable improved toilets</td>
<td>88 (97.8%)</td>
<td>62 (95.4%)</td>
<td>20 (95.2%)</td>
<td>.674</td>
</tr>
<tr>
<td>Sex-separate usable improved toilets</td>
<td>76 (84.4%)</td>
<td>54 (83.1%)</td>
<td>19 (90.5%)</td>
<td>.713</td>
</tr>
<tr>
<td>Handwashing facilities</td>
<td>90 (100%)</td>
<td>65 (100%)</td>
<td>21 (100%)</td>
<td>–</td>
</tr>
<tr>
<td>Handwashing facilities with water</td>
<td>86 (95.6%)</td>
<td>65 (100%)</td>
<td>21 (100%)</td>
<td>.141</td>
</tr>
<tr>
<td>Handwashing facilities with water and</td>
<td>79 (87.8%)</td>
<td>64 (98.5%)</td>
<td>18 (85.7%)</td>
<td>.038*</td>
</tr>
</tbody>
</table>

Note: Cells containing no p-value (–) are those where the chi-square test was not performed due to the presence of a constant variable. *p value < 0.05; **p value ≤ 0.001

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time or less per week. In addition to that, toilet paper was not available in almost half (58.5%) of the toilet facilities. As for waste management, except for 5.7% of schools who reported throwing waste in open air, incineration (67%) and municipal system waste management (29.4%) were the most common waste elimination methods.

**Sanitation coverage.** Overall, 84.7% of schools were found to fulfill basic sanitation criteria (improved, single-sex, and usable facilities). Except for Garoua 3 where about 5% of schools lacked toilets facilities, all the schools located in the other sub-divisions had latrines facilities. However, for about one-fifth of them, even though improved, the latrines were not separated based on gender. When it comes to basic sanitation coverage, Garoua 2 had the lowest coverage (83.1%) and Garoua 1, the highest (90.5%). All the schools that lacked sanitation facilities were publicly managed and of the primary level of education (Table 4). Similarly, private schools had 89.1% of basic sanitation coverage compared to 82.6% in public schools. When looking at the coverage according to the education level, pre-primary, primary, and secondary schools had 77.8%, 85.1%, and 100% respectively.

**Hygiene practices.** Overall, each school had a median of 3 (IQR: 1–5) functional hand washing points with water and soap. Only 8% of schools reported missing either water or soap or both at the hand washing points. Collective hand washing activities was organized daily for 37.5% of schools compared to 54.5%, which either did it one or less time per week or never (Table 3). Despite 91.5% of schools were found to have water and soap available for hand washing stations (basic handwashing practices), only 30.7% of school principals declared water and soap dedicated for menstrual hygiene were also available (Table 3). In addition to that, education to menstrual hygiene was effective in 27.8% schools and bathing areas available in 2.3% schools.

Schools from all the sub-divisions, both school type of management, and schools issued from the three different levels of the Cameroon’s education system had 100% of hand washing station points available with more than 95% of them having ready-to-use water (Table 4). That percentage dropped to approximately 90%, when it came to schools having water and soap available.

**Identify disparities related to WASH access in schools located in Garoua**

Two-thirds (67.6%) of schools accessed all the three most basic WASH services i.e., the schools had improved drinking water source on premises, single-sex usable improved latrines facilities, and hand washing stations with water and soap available (Fig 1). All the schools were able to meet the threshold for basic access for at least one of the three WASH practices. Disparities in WASH access in schools were identified in the study area at three levels: geographical, education, and type of school management levels.

At the geographical or administrative level, there was a significant difference (p = 0.038) in basic hygiene service coverage in schools depending on the location.

At the education level, the pupil-to-latrine ratio significantly increased (x²) with ascending school level (p ≤ 0.001).

At the school management level, private schools tended to have achieved basic drinking water services in their majority (95%) compared to public schools (74%) and this difference was significant (p = 0.001). Moreover, the pupil-to-latrine ratio was almost 25% lower in private schools compared to public schools and the difference was significant (p = 0.004). Also, the majority (80%) of schools with a private management tended to have the three basic WASH service threshold met and almost none (1.8%) of them had only one WASH service available compared to public schools (p = 0.014).
The proportion of schools meeting each of the 11 WASH indicators was calculated and the results presented in Fig 2. Overall, except for one indicator (basic drinking water, 80.1%), at least 84% of schools in the study area met the criteria for each of the other indicators. The response rate was 100% for all the WASH-in-schools indicators composite scale items. But, one item was constant and was removed from the scale. The multidimensionality of the scale was assessed and three main latent components identified: water access, sanitation, and hygiene. The Cronbach’s Alpha value with the ten retained items was 0.77 showing an acceptable reliability of the scale.

The WASH-in-schools indicators composite score was computed by adding the score each school made for each of the 10 indicators retained and ranged from 2–10, with a mean of 9.08 ±1.61. When assessing the correlation between the WASH indicators composite score and the different characteristics of schools reported in the study area, private schools were more likely to have a high total score (p = 0.014) and a high-water access sub-total score (p = 0.004). In addition to that, Garoua 2, were more likely to have a higher hygiene sub-total score (p = 0.043) compared to Garoua 1 and 3 and the difference was significant (Table 5). Assessing the correlation between the composite score and the school size showed no significance. But, when focusing on student composition, schools with students with limited mobility tended to have worse water access scores (r = -0.139, p = 0.066) as well as worse composite scores (r = -0.126, p = 0.096) even though the difference was marginally significant.
Table 5. Assessment of the correlation between the WASH indicators composite scoring against North Cameroon school characteristics (N = 176).

<table>
<thead>
<tr>
<th>School Education Level</th>
<th>School Management</th>
<th>Type of Private Management</th>
<th>School Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>Water Access</strong></td>
<td><strong>Sanitation Facilities</strong></td>
<td><strong>Hygiene Practice</strong></td>
</tr>
<tr>
<td><strong>Indicators</strong></td>
<td>Values</td>
<td>Significance</td>
<td>Values</td>
</tr>
<tr>
<td>Pre-primary</td>
<td>10.04 ±1.59</td>
<td>2.60 ±0.91</td>
<td>4.46 ±1.07</td>
</tr>
<tr>
<td>Primary</td>
<td>9.99 ±1.71</td>
<td>P = 0.474</td>
<td>2.52 ±1.01</td>
</tr>
<tr>
<td>Secondary</td>
<td>10.82 ±0.39</td>
<td>2.82 ±0.39</td>
<td>5.00 ±0.00</td>
</tr>
<tr>
<td>School Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>9.88 ±1.77</td>
<td>2.43 ±1.04</td>
<td>4.57 ±0.99</td>
</tr>
<tr>
<td>Private</td>
<td>10.52 ±1.06</td>
<td>P = 0.014*</td>
<td>2.87 ±0.57</td>
</tr>
<tr>
<td>Type of Private Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laic</td>
<td>10.40 ±1.18</td>
<td>2.87 ±0.55</td>
<td>4.56 ±1.10</td>
</tr>
<tr>
<td>Confessional</td>
<td>10.69 ±0.87</td>
<td>P = 0.327</td>
<td>2.86 ±0.62</td>
</tr>
<tr>
<td>School Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garoua 1</td>
<td>10.00 ±1.62</td>
<td>2.52 ±1.01</td>
<td>4.64 ±0.87</td>
</tr>
<tr>
<td>Garoua 2</td>
<td>10.23 ±1.44</td>
<td>P = 0.660</td>
<td>2.67 ±0.79</td>
</tr>
<tr>
<td>Garoua 3</td>
<td>10.00 ±2.04</td>
<td>2.47 ±1.07</td>
<td>4.66 ±1.15</td>
</tr>
</tbody>
</table>

*Significant p value

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Discussion

This study offers perspective on the WASH technical and human development components in the Cameroonian educational system as well as provides insight about the types of services that pupils currently benefit from. The findings of this research showed suboptimal drinking water supply and sanitation facilities whereas most schools had hand washing points available. However, activities that aimed to promote and sustain a WASH positive environment among children still need to be put in place. In addition to that, disparities in WASH-related infrastructures exist depending on the school location, the school level of education (pre-primary, primary, or secondary), and privately owned schools tend to be more compliant towards JMP WASH guidelines than their government managed counterparts. Furthermore, despite individual WASH component coverage seemed high, up to one-third of schools in the study were classified as not having all the three basic WASH services and these included 80% of public schools.

The JMP report on progress on WASH in schools reveals an inconsistency in results in sub-Saharan Africa and more specifically in Cameroon, due to insufficient reporting of WASH in schools [13]. This absence of data assessing the extent and gaps in WASH-in-school coverage represents a huge barrier that needs to be overcome especially in this era marked by the COVID-19 pandemic, to provide WASH-related infrastructures to those who are really in need. One-third of schools in our study could not meet the criteria for basic services for the three WASH interventions and most of these schools were publicly managed. Similar results were found in the North-West region of Cameroon, where limited WASH infrastructures were identified as well as disparities in public vs. private schools [27]. This could be because the construction of infrastructures such as latrine facilities or water pumps in public schools is mostly the responsibility of the “Parents Teachers Association.” It is made up of school authorities as well as parents whose children are enrolled in a specific school, and its funding comes from a fraction of school fees that is generally minimal compared to what is collected in private schools. Because the success of WASH programming in schools requires teamwork and acknowledging the crucial role parents can play in facilitating the implementation of WASH-related measures, the “SWASH+” project in rural Kenya taught parents to inspect school WASH facilities to augment school administrators’ accountability for providing WASH services [28]. Further, the Ministry of Education should target greater investments in WASH in schools interventions through promoting public-private partnership.

Even though the basic water supply coverage seemed high compared to the national estimates both overall and per level of education, the nature of the water source could represent an issue to its proper and safe utilization mainly among younger age students. Furthermore, even though marginally significant, schools with students with handicaps tended to have worse total WASH-in-school composite scores. Protected wells consist in a hole dug by hands with a lining, either a concrete or a metal cover, and a bucket attached to a rope to raise the water. The UNICEF recommends WASH facilities that should be age appropriate, simple to use, and prevent children’s harm [29]. In this study, the lack of budget can explain the presence of wells as water supply system in schools where students’ age is normally comprised between 6 and 12 years old. In a research conducted in the West region of Cameroon, adult caretakers reported avoiding sending their young children to fetch water from wells due to the danger it represented for them as well as the fact that they were limited by their age to follow the required rules to keep the well water free from external contamination such as avoid putting the bucket or the rope on the floor while fetching [30]. Hence, even though water sources described as improved are existing in a school setting, it does not imply that those water sources are adequate to meet and maintain hygiene and sanitation requirements. In addition
to this inadequate water supply system, we also noted a high student per facility coverage and only 51.7% of all water sources remained functional throughout the year. In such instances, the WHO recommends that students and staff should bring water from home as an essential short-term measure to protect health in school. A study conducted in Nigeria, reported that despite many of the investigated schools did not have water source in their compound, their students generally brought water from home [31].

Similar to these findings, a study in Tanzania assessing a WASH intervention reported that most of the budget was dedicated towards hardware interventions consecutive to regular breakdowns [32]. Concerns have been raised by researchers working on measuring water access at the household level, highlighting that the UN-Water indicators of nature of water source (improved/unimproved) and distance or time spent to the water source, were likely to underestimate the problem of household water insecurity by overlooking the experiential nature of poor water access [33]. Indicators used by the SDG to monitor progress toward achieving water access in schools take into account the proportion of schools meeting basic water services threshold without considering whether that water source even though functional is actually usable by the children. Research focusing on students might be of utmost importance to portray the experience they have of water scarcity in school as this could justify the need to create experiential based scales that would better capture access to enough clean water for an efficient school journey. The WASH-in-schools indicators composite score represents an objective tool that could be used to strengthens existing UN indicators and more research should be done to review, plan, and develop such a scale to monitor and evaluate progress towards WASH-in-schools related SDG.

One latrine facility was available for use to 76 students (similar ratio for boys and girls), 25% higher than the WHO recommendation of 50 boy-students per latrine, and only 4% of schools met the WHO standard of 25 girls to one latrine. Our findings are similar to Manjong-Kofete et al. (2021) in the North West Cameroon and Ashu et al. (2021) in the South West Cameroon who reported very high pupil to latrine ratios [19, 27]. A multinational cross-sectional WASH study documenting WASH access in 2,270 schools in six sub-Saharan Africa countries also found a largely insufficient ratio of sanitation facilities to students given the WHO recommended ratios [10]. This poor sanitation coverage highly increases the risk for open defecation practice, which coupled to the very high levels of food insecurity observed in these regions, augments students’ susceptibility to infectious diseases with subsequent decreased cognitive productivity. Recognizing that inadequate access to safe water and sanitation services and low hygiene practices result in 20% of the total childhood disease burden globally, interventions aiming at building adequate sanitation facilities in Cameroon schools should be encouraged. Additionally, the discrepancy existing in this study and elsewhere [3, 10], between the proportion of schools meeting the WHO student-to-latrine ratio recommendation for boys vs. girls emphasizes the need to put more resources into improving sanitation infrastructures for girls, therefore addressing targets #4.5, #5.1, and #6.2 of the 2030 SDG.

Despite 91.5% of schools met the threshold for basic hygiene services, one station was available to serve more than 100 students. According to WHO (2009), hand washing stations should be used at least after using the toilets and before eating, which would be hardly feasible in a setting where one water source is also available for 200 students. Garoua, as a city with significant rural exodus and host town from thousands of refugees should benefit from financial aid for school infrastructures to cope with the rapidly growing school age population [34].

To the best of our knowledge, this study is the first study to assess WASH coverage in schools located in the northern part of Cameroon, a region of the country marked by recurrent sanitary emergencies, the highest prevalence of acute malnutrition, and representing the largest and heaviest focus of food and water insecurity. The study used recommended guidelines
to build a questionnaire making the calculation of the core indicators more reliable and useful for comparison across settings and contributing to harmonize data with WASH in schools related indicators applied in national surveys [8]. However, combining interviews of students and teachers and addressing the uses of and the quality of WASH facilities in the selected schools could have added insight as for how the lived experience of WASH in schools is, considering the reporting bias that could occur from interviewing school authorities. Moreover, the study took place both in the dry and the rainy seasons and included most of the schools of the study area. Hence, despite its cross-sectional design, the results are highly likely to be representative of the WASH-in-school situation in the urban-Northern part of Cameroon. The study developed a WASH-in-school composite score, providing an assessment of the holistic spatial dimensions of the problem and that could be used to identify hotspots lacking WASH infrastructural facilities. The results demonstrated statistically significant disparities in WASH access at the school management level. This could offer the policy-makers, feasible means to strategize optimal interventions [35].

**Conclusion**

More efforts should be enabled to assess WASH indicators in non-household settings in order to track the progress toward international WASH targets and to put in place adequate strategies that could lead to integrating WASH program into national education policy. The WASH-in-schools indicators composite score predictive value corroborated the disparities related to WASH access in schools located in Garoua. Hence, observational research focusing on the condition and use of the different WASH facilities would be of huge interest and further research should be conducted to obtain a composite score aggregated from the core questions and indicators that could serve to explore nationwide WASH-in-school profiles. Governments should review their policies regarding the WASH-related requirements before an educational institution is deemed operational and to be upgraded concomitantly with the school population growth. This will contribute to reduce the incidence of WASH related diseases in schools.

**Supporting information**

S1 Text. Questionnaire. (PDF)

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