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Water, Sanitation, and Hygiene (WASH) in Schools: A Catalyst for Upholding Human Rights to Water and Sanitation in Anápolis, Brazil

Carmencita Tonelini Pereira [1], Sabrina Sorlini [1], Josivaldo Sátiro [2] and Antonio Albuquerque [2,*]

[1] CeTAmb, Department of Civil, Environmental, Architectural Engineering and Mathematics, University of Brescia, 25123 Brescia, Italy; c.tonelinipereira@unibs.it (C.T.P.); sabrina.sorlini@unibs.it (S.S.)
[2] GeoBioTec, Department of Civil Engineering and Architecture, University of Beira Interior, 6200-358 Covilhã, Portugal; josivaldo.satiro@ubi.pt
* Correspondence: antonio.albuquerque@ubi.pt

Abstract: Ensuring access to water, sanitation, and hygiene (WASH) facilities, along with behavior change education in schools, is essential for fostering a conducive learning environment and promoting principles of inclusion, dignity, and equality. This study focuses on 12 primary schools in Anápolis, Brazil, with a total of 4394 students and 248 teachers. WASH assessments were conducted using a questionnaire, observations of water and sanitation facilities, and microbiological analysis. Between 2018 and 2020, the proportion of schools with safely managed drinking water increased from 42% to 92%. However, sanitation conditions in the schools were categorized as basic, with hygiene services rated as limited in 92% of the schools due to the absence of soap. While this study shows that Anápolis schools generally meet WASH guidelines for basic/advanced drinking water services, there is a crucial need for improvements in both hardware and software facilities to address sanitation and hygiene challenges.

Keywords: drinking water; human rights; SDG 6; services ladders; wash in schools

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1. Introduction

Population growth and increased contamination of aquatic ecosystems are factors that must be monitored to achieve better drinking water distribution [1]. During the Millennium Development Goal (MDG) period, the international monitoring of water, sanitation, and hygiene (WASH) services in developing countries relied predominantly on household surveys identifying access to "improved" and "unimproved" services. However, these indicators fell short of the key health-based conditions that the MDG water and sanitation targets sought to encourage [2].

The Sustainable Development Goals (SDGs) consist of 17 global goals set by the United Nations General Assembly in 2015 as part of the 2030 Agenda for Sustainable Development. Each goal has specific targets to be achieved by 2030. At the start of the SDGs period, there is an opportunity to learn from these limitations and better align indicators and measures with intended outcomes [2]. The safe management of WASH services is still not widespread in the so-called poorest areas of the world. For instance, according to reports by the World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) [3], in 2017, 673 million people still practiced open defecation, and 435 million people used unimproved water sources. Thus, quality water services are not universally guaranteed throughout the world and, where they apparently are, there may be changes due to climate change, particularly with regard to water scarcity.

It is in this context that this work, attributable to targets 6.1, 6.2, and 6.3 of SDG 6 and target 4a of SDG 4, is of fundamental importance to guarantee better access for the school community to basic services essential for health, such as safe drinking water, soap for handwashing, clean bathrooms, sewage collection, and treatment.

Thus, water treatment and supply systems are designed to supply drinking water to populations, while drainage and wastewater treatment systems serve to remove excreta from urban settlements. Both solutions are intended to prevent water-related diseases. Currently, solutions must consider the integrated use of water, including the reuse of treated wastewater, and nature-based solutions that are well integrated and have low operating and maintenance costs in urban areas can be used. These facilities as well as hygiene practices are the key points of the SDG n.6 [4]. According to Bain et al. [5], there are some limitations to SDG monitoring approaches: (i) direct measurement of water quality; (ii) use of a binary indicator that reflects a poor range of services for people; (iii) emphasis on national media without taking into account the most marginalized members of society; (iv) failure to consider the levels of treatment of reclaimed water.

Starting from that point, the global endeavor to achieve sanitation and water access for everyone by 2030 expands beyond households to encompass institutional settings, including schools, healthcare facilities, and workplaces. This shift has been strengthened by global education strategies emphasizing how WASH (Water, Sanitation, and Hygiene) programs in schools enhance access to education and improve learning outcomes, especially for girls, by creating a safe, inclusive, and fair learning environment for all [4]. According to the WHO-UNICEF evaluation in 2021, access to basic drinking water services (water from a good source available at the school) varied from 46% in low-income countries to 100% in high-income countries. For basic sanitation services, the coverage ranged from 47% in low-income countries to 100% in high-income countries. Hygiene services were particularly challenging in low-income countries, with only 23% of schools having soap and water for handwashing [6].

For the first time, the global policy agenda includes early childhood education as an unambiguous priority. SDG 4 calls for "quality ... pre-primary education" for all children to achieve universal, inclusive, equitable education; prepare children for school; and promote life-long learning. SDG target 4a calls for "safe, non-violent, inclusive and effective learning environments", and indicator 4.a.1 calls for appropriate sanitation and handwashing facilities, as well as access to drinking water [7].

According to WHO-UNICEF [3], having water, sanitation, and hygiene facilities in schools has various clear advantages. Having a safe water supply and encouraging regular drinking improves cognitive performance. Implementing good hand hygiene helps lower the risk of diseases, keeping children healthy and reducing absenteeism. Additionally, having accessible and suitable toilets enhances well-being and improves concentration during classes. Specific obligations about access to safe drinking water and sanitation have also increasingly been recognized in core human rights treaties, mainly as part of the right to an adequate standard of living and the right to health.

The JMP reports that, in 2016, 335 million girls attended school without access to water and soap for washing their hands, bodies, and clothes. Moreover, over 620 million girls and boys worldwide lack basic sanitation services at their schools [4].

At the international level, the human right to water and sanitation was established by the 2010 United Nations General Assembly with resolution A/RES/64/292. Considering the worrying situation of people without access to drinking water and sanitation, which in 2010 represented 884 million and 2.6 billion, respectively [8], the resolution recognizes equitable access to drinking water and sanitation as an integral component of access to all human rights. It confirms the responsibility of states as promoters and protectors of such rights.

Human rights indicators were developed to monitor specific legal norms. They reflect and measure all human rights elements related to water and sanitation, including availability, accessibility, quality, affordability, and acceptability. A health-based approach using water service levels was proposed in 2003, and a human rights-based approach was adopted in 2008 [2]. Thus, the WHO/UNICEF Joint Monitoring Program on WASH

(JMP) has developed service ladders for WASH in schools to make it easier to benchmark and compare progress across countries. These service ladders are based on categorizing facilities as either improved or unimproved, primarily to monitor advancements toward a basic level of drinking water, sanitation, and hygiene services. This categorization serves as the chosen indicator for globally tracking progress toward the WASH-related SDG targets in schools.

Multi-level service ladders for monitoring WASH in schools (Figure 1) allow countries at different development stages to track and compare progress in reducing inequalities. There are separate ladders for drinking water, sanitation, and hygiene. Within each category, the core service ladders include three levels: no service, limited service, and basic service, where the "basic" service threshold corresponds to the SDG indicator for Target 4a.

Drinking water	Sanitation	Hygiene
Advanced service: criteria based on human rights: quantity, accessibility, acceptability, quality (water free microbiological contaminations)	**Advanced service:** student per toilet ratios, cleanliness, accessibility to all users, menstural hygiene facilities, sewage collection and treatment	**Advanced service:** student per handwashing stations ratios, higiene education, menstrual hygiene materials, accessibility to all users
Basic service: drinking water from an improved source and available at the school	**Basic service:** improved sanitation facilities at the school that are usable (available, functional and private) and separated by sex	**Basic service:** handwashing facilities with water and soap available at the school
Limited service: drinking water from an improved source but water is unavailable at the school	**Limited service:** improved sanitary facilities not separated by sex and not usable	**Limited service:** handwashing facilities with water but no soap available
No service: drinking water from an unimproved source or no water source at the school	**No service:** unimproved sanitation facilities or no sanitation facilities	**No service:** no handwashing facilities or no water available at school
Note. Improved sources include piped water, boreholes or tubewells, protected dug wells, protected springs and packaged or delivered water. Unimproved sources: unprotected wells, unprotected springs, surface water.	Note. Improved sources include flush/pour flush toilets, ventilated improved pit latrines, composting toilets and pit latrines with a slab or platform. Unimproved sources: pit latrines without a slab or platform, hanging latrines and bucket latrines.	Note. Handwashing facilities may be fixed or mobile, and include sink with tap water, buckets with taps, tippy-taps and jugs or basins designated for handwashing. **Soap** includes bar soap, liquid soap, powder detergent and soapy water but does not include ash, soil, sand or other handwashing agents.

Figure 1. New JMP service ladders for monitoring WASH in schools in the SDGs [4].

In countries where achieving a "basic" level of service is not seen as an ambitious goal and there are extra resources for monitoring, we propose an additional "advanced" service level. This level is determined by human rights criteria, including availability, accessibility, quality, affordability, and acceptability.

The Human Right to Water and Sanitation in Brazil

Brazil successfully met the MDG by cutting in half the percentage of the population without access to clean drinking water by 2015. As the SDGs were introduced, focus turned to addressing the most urgent areas lacking services or having low-quality services, along with addressing inequalities between rural and urban areas [9]. Despite compliance with MDG 7 for drinking water, official indices and data available in the National Health Information System (NHIS), prepared by the Ministry of Cities, demonstrate that, from 1995 to 2015, access to drinking water and services in the sanitation sector made progress, but from 2016 to 2019 it stagnated, as can be seen in Tables 1 and 2 [9].

Table 1. Information on drinking water in Brazil 2015–2019 [9].

Years	Brazilian Population (Million)	Population Served with Drinking Water (Million)	Investment (R$)
1995	162	84.6 (52.2%)	65×10^6
2000	174	95.1 (54.6%)	102×10^6
2015	204.5	164.8 (80.5%)	5.7×10^8
2016	206.2	166.6 (80.5%)	5.9×10^8
2017	207.8	167.7 (80.7%)	5.5×10^8
2018	209.5	169.1 (80.7%)	5.7×10^8
2019	210.0	170.8 (81.3%)	5.7×10^8

Table 2. Information on sanitation in Brazil 2015–2019 [9].

Years	Brazilian Population (Million)	Population Served with Sanitation (Million)	Investment (R$)	Volume of Wastewater Treated (%)
1995	162	30.3 (18.5%)	41.5×10^5	9.2
2000	174	39.8 (22.8%)	96×10^6	61.2
2015	204.5	99.8 (48.6%)	5.2×10^8	73.3
2016	206.2	103.8 (50.3%)	4.2×10^8	74.8
2017	207.8	105.2 (50.6%)	3.8×10^8	73.9
2018	209.5	107.5 (51.3%)	4.7×10^8	74.5
2019	210.0	110.3 (52.2%)	5.3×10^8	78.5

In terms of drinking water supply, there was an increase in investment in infrastructure by around nine times in ten years (from 1995 to 2015) and then a decrease in the following years. Between 1995 and 2015, the portion of people connected to wastewater collection grew from 18.5% to 48.6%, accompanied by a significant rise in investments (125 times more than the 1995 value). However, investments decreased by around half a billion R$ in 2017, due to political choices, which ended up delaying the implementation of treatment infrastructures. The increase in investment between 1995 and 2015 was carried out essentially in large cities, with little significance in rural areas where problems of access to drinking water and wastewater sanitation persist, with a negative impact on people's health and quality of life, particularly in the states of the northern and northeastern regions of the country.

Despite the increase in financial resources for the WASH sector between 2000 and 2015 (MDG period), a human rights approach is necessary to better address the inequalities and critical issues that still exist between regions, mainly in the North and Northeast of Brazil. Low investments in drinking water supply and sewage treatment have a direct impact on the quality of life and health of Brazilians, especially for the 40 million without access to treated water and more than 99 million without sewage collection and treatment [9].

In 2013, the National Plan for Basic Health Services (PLANSAB) was approved with objectives for a time horizon of 20 years (2013 to 2033). The PLANSAB has 29 objectives, with eight indicators for water supply, six for wastewater, and eight for municipal solid waste. The plan prioritizes eliminating open defecation, achieving universal access to safely managed water, and achieving at least 92% access to safely managed sanitation by 2033. Additionally, according to the plan, expanding access to WASH helps reduce regional and local inequalities [10]. The PLANSAB includes adequate water, sanitation, and hygiene in institutions and, therefore, in schools. Even in the school context, disparities must be taken into account and greater attention must be given to the most vulnerable groups: the poor, favela residents, indigenous populations, ethnic minorities, and rural populations [11].

JMP estimates indicate that 39% of schools in Brazil lack basic handwashing facilities [12]. A stark contrast exists between private schools, which have more than double the facilities compared to public schools, and among different regions. For instance, only 19% of public schools in Amazonas have a water supply, well below the national average of 68%. The sanitation crisis is even more severe; some northern states report that fewer than 10% of schools have access to sewage collection and treatment [13]. Specifically, only 9% of public schools in Acre, 5% in Amapá, and 6% in Rondônia have access to sewage networks [13].

World experience [3–8] says that, from a statistical and health point of view, in schools where there are sanitation and water supply systems, learning is high, there are fewer outbreaks of diseases such as diarrhea, school dropout rates decrease, and there is an improvement in the quality of life of the students. In rural regions of Brazil, due to low investment, access to drinking water and wastewater sanitation and solid waste is low [10], the main novelty of this study being the assessment of the causes and deficiencies of these services in a rural region of the State from Goiás.

Therefore, this research aimed to evaluate the level of WASH services in 12 public schools (including students and teachers) of the municipality of Anápolis (Brazil) and suggest measures for improving these services and implementing good WASH management practices in schools.

2. Materials and Methods

The assessment of the WASH services level demands a careful study of water quality, toilet facilities, handwashing with soap, disposal of wastewater, and responsibility for maintenance and repair of the school's water and sanitation system.

2.1. Study Site

Anápolis is a Brazilian municipality located in the central–western region of Brazil in the State of Goiás. It is situated between Brasilia and Goiania and has become the state's industrial center, mainly in the pharmaceutical sector. The city has more than 398 thousand inhabitants [14]. The education census shows that in Anápolis there are 143 public schools with 63,250 students, of which 100 are municipal with 35,750 students and 43 do not have a public wastewater collection and treatment system [15].

For this study, twelve public primary schools from Anápolis (Brazil) were selected, nine urban and three rural schools covering 4394 students and 248 teachers. The criteria used to select the institutions were the geographic distribution seeking to cover the north, south, east, and west regions, as shown in Figure 2. The schools were chosen in relation to their location equidistant from the main urban center, Anápolis.

Figure 2. Location of schools under investigation.

2.2. Data Collection

Before beginning the study, all participating schools needed to sign a consent form, agreeing to the collection of data and water samples for microbiological analysis. The research received approval from the Municipal Secretary of Education in Anápolis.

The research was carried out over 24 months and two WASH evaluations were carried out, one at the beginning of the project and another at the end, to compare the results and verify whether the actions implemented in schools had significant effects. Each school was visited six times: four times to collect water for microbiological analysis and twice to assess WASH services.

The data were collected through structured observations of the facilities, using a questionnaire developed according to the recommendations of the WHO and UNICEF: WASH in Schools Monitoring Package and Core questions and indicators for monitoring WASH in Schools in the SDGs [4]. The questionnaire consisted of six blocks divided into general information about the school; water management (17 questions); sanitation (13 questions); hygiene (14 questions); waste disposal (9 questions); and operation and maintenance (10 questions).

The questionnaire focused on key WASH issues, including general information on the school, main water sources, functionality and quality, accessibility for youngest children and physical disabilities, handwashing facilities, cleanliness and accessibility of toilets and availability of soap, operation, and maintenance of systems, and disposal waste. It also seeks to generate important insights into the needs for improvement and appropriate maintenance of the schools, considering not only standard provision of hardware such as WASH infrastructure but also aspects that affect pupils and hinder acceptability, such as cleanliness, safety, privacy, and provision of consumables.

2.3. Data Analysis

The WASH assessment was made using several tools for collecting valid information on water, sanitation, and hygiene services.

Questions on drinking water aimed to determine the type of source and availability of the school's main drinking water and were based on JMP definitions of "improved" and "unimproved" sources. These criteria are sufficient to calculate the "basic" water service in schools. Tables 3 and 4 show how the questions in the questionnaire were grouped to calculate the percentage of basic and advanced WASH services (drinking water, sanitation, and hygiene) in schools, considering human rights indicators such as accessibility, quality, and safety. Sanitation questions are designed to determine whether schools have restrooms and whether the school's sanitation facilities are usable, functional, and separated by gender. Data were tabulated using the Excel 2019 software for Windows.

Table 3. Calculation of the WASH level for drinking water based on indicators and questionnaire [4].

Level Services	Indicators	Calculation
Basic service	Proportion of schools with an improved drinking water source	The number of schools where Q2 = an improved source, divided by the total number of schools surveyed
	Proportion of schools with drinking water available from improved source	The number of schools where Q2 = an improved source AND Q1 = Yes, divided by the total number of schools surveyed
Advanced service (safety and accessibility)	Proportion of schools with drinking water available from improved source, accessible to children with disabilities and younger, and free from fecal contamination	The number of schools where Q2 = an improved source AND Q1; Q15; Q16 = yes, Q11 = Yes by *E.coli*, divided by the total number of schools surveyed
Advanced service (accessibility)	Proportion of schools with drinking water available from improved source, accessible to children with disabilities and younger	The number of schools where Q2 = an improved source AND Q15, Q16 = Yes, divided by the total number of schools surveyed
Advanced service (quality)	Proportion of schools with drinking water source free from fecal contamination	The number of schools where Q2 = an improved source AND Q11 = Yes, divided by the total number of schools surveyed

Table 4. Calculation of the WASH level for sanitation and hygiene based on indicators and questionnaire [4].

Level Services	Indicators	Calculation
	Sanitation	
Basic service sanitation	Proportion of schools with improved toilets	The number of schools where Q2 = an improved source, divided by the total number of schools surveyed
	Proportion of schools with improved toilets which are usable	The number of schools where Q2 = an improved source AND Q3 $\geq$1, divided by the total number of schools surveyed
Advanced service (accessibility)	Proportion of schools with toilets accessible to children with disabilities and younger	The number of schools where Q8 = yes AND Q9 = yes, divided by the total number of schools surveyed
Advanced service (quality)	Proportion of schools with toilets separate for girls and boys and cleanly	The number of schools where Q4 AND Q5 = yes divided by the total number of schools surveyed
	Hygiene	
Basic service	Proportion of schools with handwashing facilities that have water and soap available	The number of schools where Q8 = Yes AND Q11 AND Q12 = Yes, soap and water, divided by the total number of schools surveyed
Advanced service	Proportion of schools with handwashing facilities accessible to children with disabilities and younger	The number of schools where Q13 AND Q14 = yes, divided by the total number of schools surveyed
Advanced service (hygiene education)	Proportion of schools with hygiene education and program on menstrual hygiene for girls	The number of schools where Q1, Q3, Q4, Q5, Q7 AND Q17 = yes, divided by the total number of schools surveyed

2.4. Microbiological Analysis

Microbiological analysis of water was carried out according to the standard methods of APHA [16]. The analysis was performed in the microbiology laboratory of the State University of Goiás (UEG) for detecting fecal coliforms (*E. coli*). The method used was the most probable number (MPN) of total coliforms (CT) and *E. coli*, which uses the multiple tube method. The presumptive detection of CT was performed in lactated broth and confirmed in brilliant green broth and 2% bile. The detection of *E. coli* was carried out in E.C. broth, selective for the growth of Escherichia coli. The samples were incubated at 35 ± 2 °C for 48 h and 44.5 ± 0.2 °C for 24 h in the CT and *E. coli* assays, respectively. Positive tube results were interpreted according to the MPN/dL table.

In the first year, to standardize the samples, water was collected in the morning period, on the first tap on the right side of the drinking fountain and the main kitchen tap. In the second year, the water was collected at four points (water entry point at school, point of exit from the water storage tank, drinking water fountain, and kitchen main tap) to evaluate the schools' contamination.

3. Results and Discussion

The total number of students from the twelve schools was 4394 (47% female), aged between six and fifteen. There were 58 students with physical disabilities (1.25%). The number of teachers was 248 (92% female).

3.1. Drinking Water

The United Nations General Assembly declared safe and clean drinking water and sanitation a human right essential to the full enjoyment of life and all other human rights [8]. The SDG indicator 4.a.1 "percentage of schools with drinking water available from improved source" defines the basic drinking water service, where an improved source is a water delivery point that, by nature of its construction or through active intervention, is protected from outside contamination, particularly fecal matter. This includes piped water, public taps, protected dug wells, protected springs, etc.

To fulfill the SDG criteria for basic service, schools need access to an improved water source. Schools that have access to an improved source but lack water at the time of the survey are considered to have limited service. Schools relying on unimproved sources or lacking any water source are classified as having no service [4].

Adams et al. [17] recommend a secure water point accessible for staff and school children, including those with disabilities, at all times. The following ratios have to be observed: one water point for 12 students of preschool level; one water point for 20 students above a preschool level and one water point for 10 staff members.

In Anápolis, all schools had an improved drinking water source, located on the premises of schools, accessible to all when needed and available in insufficient quantities in the schoolyard. The average student-by-drinking water points ratio was 81:1. Despite having insufficient drinking fountains, water is available at all times in 100% of schools in sufficient quantity (Table 5).

The research showed that urban schools use public networks as an improved source while two rural schools use protected dug wells and one rural school uses both protected dug wells and piped networks. All schools have their water storage containers in ferro-cement or polyvinyl chloride (PVC), with capacities of 2000 to 5000 L that are cleaned by the municipal authorities in January and July months. In 10 schools (83.3%), the drinking water storage containers were properly covered. A properly covered storage tank means that the cover must avoid mosquito breeding, including species that transmit Zika and dengue virus, and help to prevent fecal contaminants and sunlight, which will promote algal growth, from reaching the water.

Table 5. Indicator WASH for drinking water and services level in Anápolis (Brazil).

				Basic Service Indicator		Advanced Service Indicator				Wash Services Level	
Schools	**Students Number**	**Number of Drinking Water Points**	**Ratios Students/Water Points**	**An improved Source at the School**	**An available Source at the School**	**Water-Free Contamination (*E. Coli*) 1st Year**	**Water-Free Contamination (*E. coli*) 2nd Year**	**Drinking Water Accessible (Limited Mobility and Smallest Children)**	**Sufficient Quantity of Water**	**1st Year**	**2nd Year**
1. Rural	263	4	65.75	Yes	Yes	No	No	Yes	Yes	basic	basic
2. Rural	213	3	71.00	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
3. Rural	545	4	136.25	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
4. Urban	250	3	83.33	Yes	Yes	Yes	Yes	Yes	Yes	advanced	advanced
5. Urban	353	3	117.67	Yes	Yes	Yes	Yes	Yes	Yes	advanced	advanced
6. Urban	725	8	90.63	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
7. Urban	284	4	71.00	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
8. Urban	250	3	83.33	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
9. Urban	525	4	131.25	Yes	Yes	Yes	Yes	Yes	Yes	advanced	advanced
10. Urban	260	3	86.67	Yes	Yes	Yes	Yes	Yes	Yes	advanced	advanced
11. Urban	436	14	31.14	Yes	Yes	Yes	Yes	Yes	Yes	advanced	advanced
12. Urban	290	2	145.00	Yes	Yes	No	Yes	Yes	Yes	basic	advanced
Total	**4394**	**54**	**81.37**						Yes		

The water is used for drinking, handwashing, food preparation, and pour-flushing toilets. The water supply is functional all day and provides enough water for the needs of the school, with four schools (33.3%) having as alternative water sources truck tankers. All urban schools receive chlorinated water directly from the water supply company and on school premises the water is treated by filtration. In rural schools, water does not undergo a chlorination process before being used, and the only method of treatment is the activated carbon filter of drinking fountains.

Additionally, school officials have reported that the school's water source, a dug well, is of good quality and safe for drinking. In all schools, students drink water from a drinking fountain that has an activated carbon ceramic filter. It was noted that 50% of schools exchanged the filter twice a year, 33% exchanged it once a year, and 17% never exchanged the filter for a drinking fountain. The height of the taps is adapted for children with physical disabilities and the youngest children. Some students bring drinking water from home to 50% of schools because the water tastes bad to them.

Figure 3 shows that 100% of schools surveyed in Anápolis had drinking water available from an improved source, availability, and accessibility to children with disabilities and younger. However, only 25% of schools had an alternative water supply, such as transport by tanker or reservoir.

In the first year, a microbiological analysis carried out in drinking kitchen tap water revealed that seven out of twelve schools (42%) had water contaminated by *E. coli*. These schools were classified as having a basic service. In the 20th month, schools' water storage tanks were washed by the city hall and eleven schools changed the drinking fountain filters. Microbiological analyses carried out in the 22nd month showed that 8% of schools, namely one rural school, identified the presence of *E. coli* in the water. Therefore, the school was classified as providing a basic drinking water service. Between the first and second year, the proportion of schools using safely managed drinking water increased from 42% to 92%, and the "percentage of schools with drinking water storage tank properly covered", increased from 83% to 100%. These indicators define the advanced and safely managed drinking water service, where the indicator for microbiological quality is *E. coli*. This increase was due to good practices implemented in hardware management such as replacing damaged water tanks and cleaning them and replacing drinking fountain filters every 6 months.

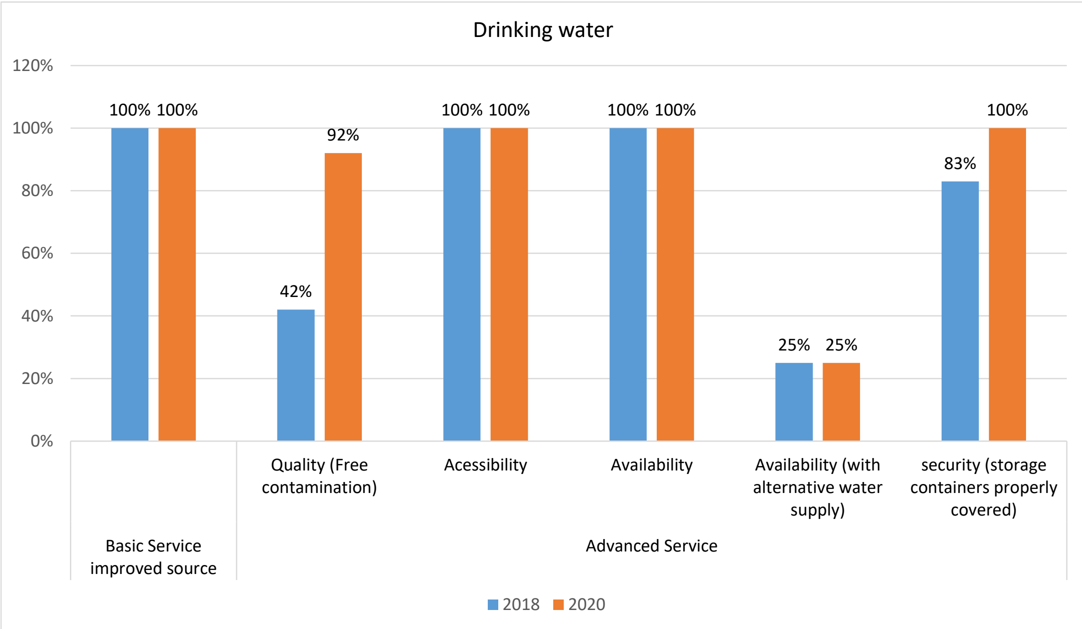

Figure 3. Drinking water: proportion of schools with basic and advanced service, Anápolis 2018–2020.

According to the WHO-UNICEF global report [6], the worldwide availability of basic drinking water in schools increased slightly from 70% to 71% between 2015 and 2021. In Brazil, data from the Ministry of Education census [15] indicate that only 8% of schools have their own water supply, and the public water network reaches just 71% of schools. However, in Anápolis, the research revealed that all schools (100%) have access to basic drinking water services. By the second year of the project, 92% of schools achieved an advanced level, ensuring safe water without microbiological contamination. This was possible through the use of the multiple-barrier method with the supply of treated water from the public network to two rural schools; replacement of drinking fountain filters every 6 months; washing of school water tanks every 6 months; replacement of cement water tanks with stainless steel or PVC water tanks. The protection of drinking water needs the use of multiple barriers, including source water protection and appropriate treatment processes, as well as protection during storage and distribution.

The project involved Brazilian and European entities, as well as the city hall and the Anápolis education department, which helped in developing WASH training courses for school officials and teachers, in addition to a student awareness campaign on the topic of water, sanitation, and hygiene management. In addition, a "WASH friendly school" guideline was created for schools with the aim of promoting the development of collaborative school management practices, basic sanitation infrastructure, technical services for installation and maintenance of equipment for treated water, bathrooms, washbasins and drinking fountains, in addition to pedagogical hygiene practices with students.

Access to water is essential for public health, work, education, and dignity, as it hinges on both availability and ease of access. Furthermore, having clean drinking water is a fundamental prerequisite for enjoying several human rights, including the rights to education, housing, health, life, work, and protection against cruel, inhuman, or degrading treatment. It is also vital for promoting gender equality and eradicating discrimination [18].

3.2. Sanitation

The guideline WHO edited by Adams et al. [17] defines one toilet for 25 girls and one for female staff; one toilet plus one urinal for 50 boys; and one for male staff. The toilets should be easily accessible to all, including staff and children with physical disabilities, male and female toilets should be entirely separated, and handwashing stations should include soap and water. Toilets should provide privacy and security and should be hygienic to use and easy to clean. The proportion of schools with a basic sanitation service defines schools with improved sanitation facilities, single-sex, and usable. Improved sanitation facilities in schools are those that effectively separate excreta from human contact and ensure that excreta do not re-enter the immediate environment. Schools with improved sanitation facilities that are either not usable or not single-sex are classified as providing a limited service [4].

The twelve schools evaluated had improved sanitation facilities. In 58% of schools, wastewater is disposed of in the septic tank (on-site system), while 42% of the wastewater is collected and treated in a sewage station (off-site system). These data are no different from the school census where, in Brazil, 47% of schools have a sewage collection system, 50% use a septic tank, and 5% do not have any form of treatment for the sewage generated [15]. Regarding sewage treatment, 58% of schools sent wastewater to septic tanks and 100% did annual maintenance on tanks. All schools had a drainage system for separating greywater from handwashing sites. In the rural schools, there was no separation between greywater and blackwater and rainwater drainage was poor.

Waste collection is an important aspect that cannot go unmentioned. If solid waste collection is not well planned and carried out, it may impact additional wastewater flows due to runoff leaching. Solid waste is collected twice a week and sent to the landfill. Only in one school there is a selective waste collection; in the others, there are containers for selective collection, but recyclable materials are not separated. In Brazil, 77% of schools have garbage collection and 23% still burn garbage as a form of recycling [16]. Irregular incineration and clandestine burning of domestic solid waste produce gases that are rich in potentially toxic substances. In addition, these components are associated with some respiratory, reproductive, and oncogenic clinical manifestations with a high impact on the health of the population. No signs of contamination or entry of leachate streams from solid waste produced in schools were found.

All of the evaluated schools had toilet facilities separated by gender and not shared with teachers. The number of toilets for students was insufficient in 100% of schools. In the twelve schools, there was a total of 76 toilets and 4394 students, of which 2098 were girls and 2296 were boys. The ratio between the number of girls and boys and the number of bathrooms was 53:1 and 62:1, respectively. In the first year, 58% of school bathrooms were observed to be inadequate for use. Typical problems were defective flush handles, toilets in disuse due to defects, and lack of hygienic conditions (dirty toilets, strong odor at the time we visited). These schools were classified as being at a limited-service level. The other schools (42%) were classified as being at a basic service level (see Table 6).

Cleaning the school environment is an important strategy for the health and permanence of students in schools. This requires the school manager to have basic materials available for regular cleaning and disinfection of the school environment, including bathrooms, classrooms, canteens, and courtyards. In Anápolis, during the visit, it was noticed that 58% of schools did not have liquid detergents and soap for cleaning. The directors mentioned that they receive limited funding, and sometimes they cannot afford to purchase necessary materials.

Table 6. Indicator WASH for sanitation and services level, Anápolis (Brazil).

	1st Year			2nd Year		Basic Service Indicator		Advanced Service Indicator				Wash Services Level	
Schools	**N. Student**	**N. Functional Toilet**	**Ratios Students/Toilet**	**N. Functional Toilet**	**Ratios Students/Toilet**	**Improved Sanitation Facilities**	**Usable (Available, Functional, and Private)**	**Accessible to Smallest Children 1st 2nd Year**	**Accessible to Children with Limited Mobility in 1st Year**	**Accessible to Children with Limited Mobility 2nd Year**	**Cleanliness**	**First Year**	**Second Year**
1. rural	263	6	43.83	6	43.83	Yes	Yes	Yes	Yes	Yes	Yes	basic	basic
2. rural	213	4	53.25	8	26.62	Yes	Yes	No	No	Yes	No	limited	basic
3. rural	545	8	68.13	12	45.41	Yes	Yes	Yes	No	Yes	Yes	limited	basic
4. urban	250	8	31.25	8	31.25	Yes	Yes	Yes	Yes	Yes	Yes	basic	basic
5. urban	353	6	58.83	6	58.83	Yes	Yes	No	No	Yes	Yes	limited	basic
6. urban	725	12	60.42	12	60.42	yes	yes	Yes	No	Yes	Yes	limited	basic
7. urban	284	4	71.00	4	71.00	yes	yes	Yes	Yes	Yes	Yes	basic	basic
8. urban	250	2	125.00	7	35.71	yes	yes	Yes	No	Yes	Yes	basic	basic
9. urban	525	6	87.50	10	52.50	yes	yes	Yes	Yes	Yes	Yes	limited	basic
10. urban	260	4	65.00	4	65.00	yes	yes	Yes	No	No	Yes	basic	basic
11. urban	436	11	39.64	11	39.64	yes	yes	Yes	Yes	Yes	No	limited	basic
12. urban	290	5	58.00	5	58.00	yes	yes	No	No	No	No	limited	basic
Total	**4394**	**76**	**57.82**	**93**	**47.24**								

After the data were presented to the secretary of education and principals, they committed to improving the cleanliness of the bathrooms and the city hall made some repairs to the bathrooms, which resulted in all schools being classified at the basic service level for sanitation services. The WASH assessment in Anápolis showed that the coverage of basic sanitation services varied widely in the first and second years of the research, increasing the proportion of schools with improved sanitation facilities by 58 percentage points (42% to 100%) (Table 6). Those results are related to good management practices implemented in schools, such as public–private partnership for the construction of a sewage treatment system in a rural school; donation of dispensers and liquid soap to schools; renovation and construction of new bathrooms; improvement in bathroom cleaning; student awareness campaign showing the importance of having a clean and healthy school for health; training managers on the importance of maintaining sanitation services.

Regarding accessibility, 58% of schools had no toilets accessible to children with disabilities and 25% had no available toilets designed for younger children. This implies that these students cannot use the services independently, respecting dignity and privacy. The Brazilian Educational Census [15] shows that the percentage of schools with accessible sanitation facilities for students with disabilities has increased rapidly in the last decade, from 7% in 2005 to 42% in 2019. Between 2009 and 2016, the percentage of schools with accessible toilets for young children doubled, from 27% to 49%. The same trend occurs in Anápolis, and Figure 4 shows that the proportion of schools with accessible toilets for disabled children increased from 42% to 83%.

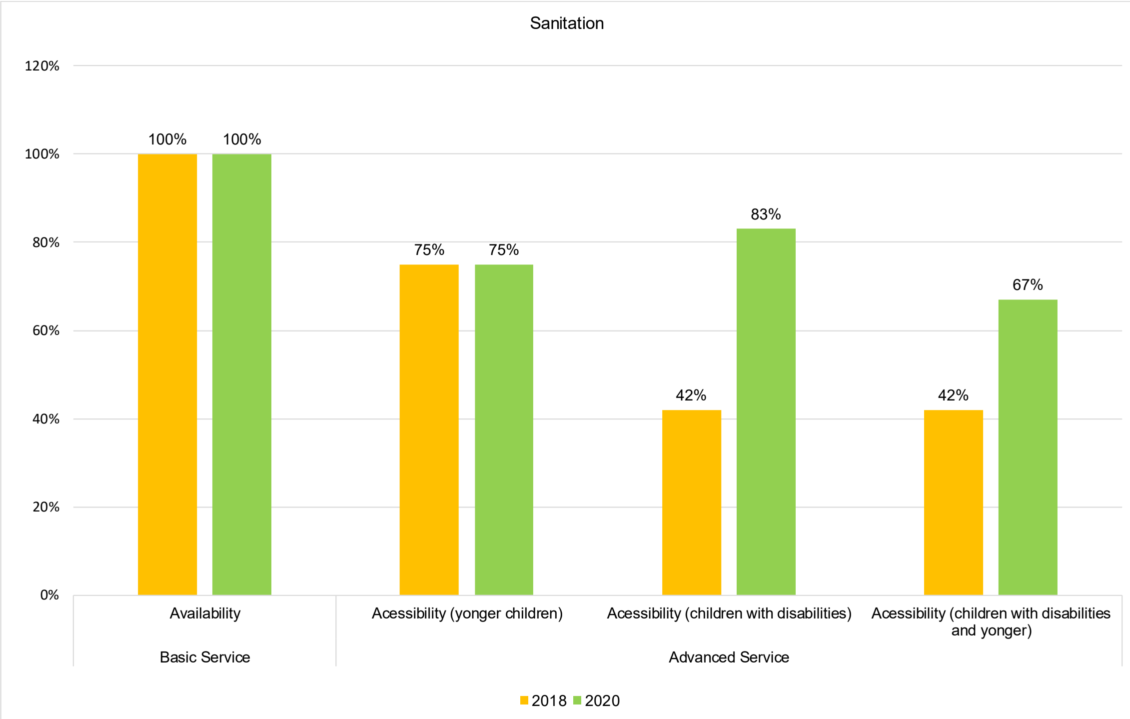

Figure 4. Sanitation: proportion of schools with basic and advanced service, Anápolis.

3.3. Hygiene and Education

Hygiene is inevitably linked to water and sanitation as a means to break the transmission of dangerous micro-organisms from feces to the mouth through dirty fingers, insects, food, floor (soil), and fluids (water). Wastewater sanitation reduces the contact with pathogenic microorganisms, water treatment reduces the transmission of diseases through consumption, and hygiene reduces the contraction and transmission of diseases through contact between the human body and contaminating agents. Hygiene education and effective use of handwashing facilities are more effective for good health than water supply improvement [19].

The indicator "Proportion of schools with basic handwashing facilities" defines the percentage of primary and secondary schools with a handwashing facility with soap and water in or near sanitation facilities. According to Adams et al. (2009) [18], the following ratios have to be observed for handwashing stations:

- One sink for eight students of preschool level;
- One sink for 15 students above a preschool level;
- One sink for 15 staff members.

A total of 100% of schools in Anápolis had handwashing (HW) stations available in insufficient quantities, the average students to HW points ratio was 46:1 (Table 7). In addition, in 25% of the schools, sink faucets were not working properly and, in some cases, leaks were causing flooding of bathroom floors.

From the first to the second year, there was an improvement in the bathrooms and the ratio of the number of students to the number of handwashing stations fell to 40:1, but this is still not enough to meet the UNICEF criteria of 15:1. Around 42% of the schools had no HW station accessible to children with disabilities and 33% had no HW points available designed for younger children. Regarding the flooding of the floors, the directors replaced the broken taps. Soap was not available in 100% of the schools, which represents an important risk of diarrheal disease contamination. These schools were classified a the limited services level because they provided water, but there was no soap available for handwashing.

Table 7. Indicator WASH for hygiene and services level, Anápolis (Brazil).

		2018		2020		Basic Service Indicator		Advanced Service Indicator			
Schools	**N. Student**	**N. HW Station**	**Ratios Students/HW**	**N. HW Station**	**Ratios Student/HW**	**HW Facilities with Water**	**HW Facilities with Soap**	**HW Facilities Accessible to Younger Children**	**HW Facilities Accessible to Children with limited Mobility**	**Hygiene Education**	**Wash Services Level**
1. rural	263	10	26.30	10	26.30	Yes	No	Yes	Yes	Yes	limited
2. rural	213	2	106.50	4	53.25	Yes	No	No	No	Yes	limited
3. rural	545	10	54.50	14	38.92	Yes	No	No	No	Yes	limited
4. urban	250	5	50.00	5	50.00	Yes	No	No	Yes	Yes	limited
5. urban	353	12	29.42	12	29.42	Yes	No	Yes	Yes	Yes	limited
6. urban	725	12	60.42	12	60.42	Yes	No	No	Yes	Yes	limited
7. urban	284	7	40.57	7	40.57	Yes	No	Yes	Yes	Yes	limited
8. urban	250	6	41.67	10	25.00	Yes	No	Yes	No	Yes	limited
9. urban	525	8	65.63	12	43.75	Yes	Yes	No	Yes	Yes	basic
10. urban	260	4	50.00	4	50.00	Yes	No	No	No	Yes	limited
11. urban	436	12	29.42	12	29.42	Yes	No	Yes	Yes	Yes	limited
12. urban	290	7	60.42	7	60.42	Yes	No	No	No	Yes	limited
Total	**4394**	**95**	**46.25**	**109**	**40.31**						

In the second year of research, only 8% of schools had soap available during the survey. This underscores the difficulty in maintaining handwashing facilities to ensure that students have access to soap and water when needed, such as before meals and after using the toilet. Regarding hygiene education, 50% of school coordinators said it is taught as a component of the basic curriculum (for example, in science classes), 33% as an integral part of a special module on healthy living and life skills, and 17% are taught sporadically. In 67% of schools, it was possible to check the hygiene education material, which stressed the importance of handwashing with soap at critical times such as after defecation and before eating. All officials replied that there is a designated period allotted for students to wash their hands before eating. However, this period was observed in only four schools (33%). In Anápolis, the percentage of schools with handwashing facilities accessible to children with disabilities increased from 42% to 75% (Figure 5).

In 2020, 47% of schools in Brazil had sanitation facilities accessible to students with limited mobility, but coverage was much lower in rural schools (20%) than in urban schools (60%), and in pre-primary schools (41%) than in secondary schools (67%). However, the biggest gap in accessibility is between federative districts: just one in six schools in Amazonas have accessible toilets, compared with nine out of ten schools in the capital Distrito Federal [6].

During the research conducted in Anápolis, it was observed that only 32% of children washed their hands after using the bathroom. Furthermore, soap was absent in 92% of schools. A major recommendation from this study is that far greater emphasis is needed on handwashing with soap before eating and after using the toilets.

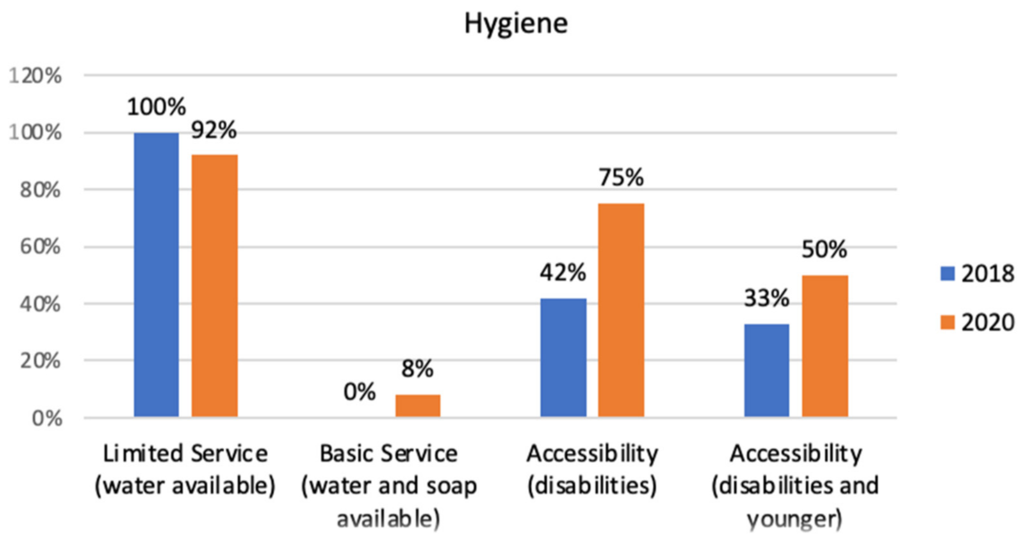

Figure 5. Hygiene: proportion of schools with limited and basic service.

Many of the problems detected could be minimized if there was periodic monitoring of the quality of water supplied to schools and the maintenance of water supply equipment. The promotion of good hygiene practices could be publicized with simple and inexpensive measures, such as displaying informative posters. It is common sense that improving hygiene is achieved mainly through education, leading to behavioral change.

However, good hygiene behavior and the effectiveness of hygiene promotion in schools are severely limited, where water supply and sanitation facilities are inadequate or nonexistent. Teachers cannot credibly convey the importance of handwashing if there is no water or soap in the school, or promote the proper use of toilets if they avoid their use because the toilets are dirty or unsafe [17]. This work can be improved, particularly regarding the application of sustainability indices such as the sanitation sustainability index (SSI), which is proposed to evaluate the sanitation systems for implementation in any community. The SSI indicates the technical, social, and economic aspects of the sanitation system [20,21].

In rural Brazil, access to clean water and adequate sanitation remains a fundamental challenge, directly impacting public health, economic stability, and education. The available results and data indicate significant disparities in access to clean water and sanitation across the study area, with many communities facing acute shortages and inadequate facilities. Access varies widely, with some remote areas almost completely unserved by modern water infrastructure. Several structures are outdated, poorly maintained, and insufficient to meet community needs, which can lead to an increase in waterborne diseases, which are a major health concern in these rural communities.

Social norms and traditional practices sometimes hinder efforts to improve sanitation and water supply, needing culturally informed intervention strategies by the local authorities. Although Brazilian law recognizes the right to water and sanitation, implementation in those rural areas is inconsistent and often ineffective. Therefore, governmental policies must be changed to address these issues, assessing their impact and selecting areas for improvement.

4. Conclusions

This study demonstrated that, generally, the schools studied in Anápolis are in compliance with WASH guidelines for basic drinking water services. However, it is necessary to improve drainage and wastewater treatment and water treatment and drinking water supply facilities, as well as to supplement the public information on hygiene practices to reduce the risk of disease through water or contact with contaminated sources. Lack of funds is a major obstacle to improving and maintaining WASH facilities. Furthermore, school officials and staff are not aware of the importance of WASH services. The need to change water filters, increase the number of bathrooms, and make soap available in all schools was detected, as well as the creation of the WASH evaluation committee, the holding of workshops on WASH for staff and teachers, and campaigns on hygiene awareness for students. The data collected in this research can be used to facilitate policy dialogue between school managers, educational administrators, decision-makers, and society at large to improve the management of WASH services. The results described here can also be used in future research to observe progress in implementing and maintaining WASH services in schools.

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