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Quality of Hand Washing in Sèmè-Podji Peri-Urban School Environment Areas, Benin

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Abstract: *Handwashing can prevent and control infectious diseases. However, to be effective, it must be done using an appropriate technique. Thus, this work aim to assess the quality of handwashing in the public primary school of Agblangandan, Sèmè Kpodji school environment: case (Benin). The study was conducted from May to July 2019. Thus, 124 samples obtained by swabbing the hands of schoolchildren, teachers, saleswomen before and after unguided hand washing and some water samples were sent to the laboratory for microbial analysis. To determine the handwashing compliance rate, a simple random draw included 230 schoolchildren, teachers and saleswomen was used. Overall handwashing adherence among schoolchildren was 32.38% of the sampled population. It was observed that teachers do not wet their hands before taking soap. In addition, they do not stress the interdigital spaces, palm, wrists and ulnar edges. Bacteriological analysis shows the presence of Staphylococcus aureus (87.09%), from Pseudomonas aeruginosa (44.35%), Escherichia coli (23.39%), Klebsiella pneumoniae (62.09%) and Serratia marcescens (16.94%). This study revealed a high manual carriage level of potentially pathogenic microorganisms and their presence in water. Training of teaching staff in health education standards and protocols as well as supervision are necessary to upgrade skills and adherence to hygiene measures.*

Keywords: *Primary school, microbiological analysis, hygiene, South-Benin*

1. INTRODUCTION

Hygiene is an essential element of public health that could reduce the transmission of pathogenic bacteria and their consequences in the population [1]. School is a place of learning conducive to behavior change for the application of hygiene measures [2]. Health education programs facilitate the establishment, within the framework of the school, of measures, which develop prevention and improve the quality of life [3]. Hands are the tool most often used by humans and are in constant contact with the environment, which contains bacteria, viruses but also toxic elements.

The United Nations Children's Fund (UNICEF) through its Water, Sanitation and Hygiene Project (PEAH) supports several school health programs in many developing countries including Benin [4]. Through this project, sanitary facilities, a supply of safe water and hand washing facilities are made available to the targeted schools. As part of this, teachers received training in teaching the skills, behaviors and knowledge necessary for effective hygienic practices [1]. Proper hand washing is one of the most effective means of preventing infectious diseases, diarrheal diseases in our context [4, 5, 7]. This is the reason why, for several years, awareness sessions on the technique of hand washing have been increasing among the populations of Benin.

Despite the remarkable progress and massive involvement in promoting health education among students in Benin, its development still faces difficulties. The number of structured and lasting actions remains limited, and their effectiveness remains difficult to assess in terms of public health, as in other countries [8]. The present study aimed at evaluating the quality of hand washing with soap and water in the Agblangandan public primary school.

2. Material and Method

It was a one-month (May 2019) transversal study base on direct and analytical observation conducted in the public primary school of Agblangandan (Figure 1). This school is located in a peri-urban area where there is no drinking water. The sampling population was composed of schoolchildren (210), teachers (13) and 7 randomly selected sales assistants.

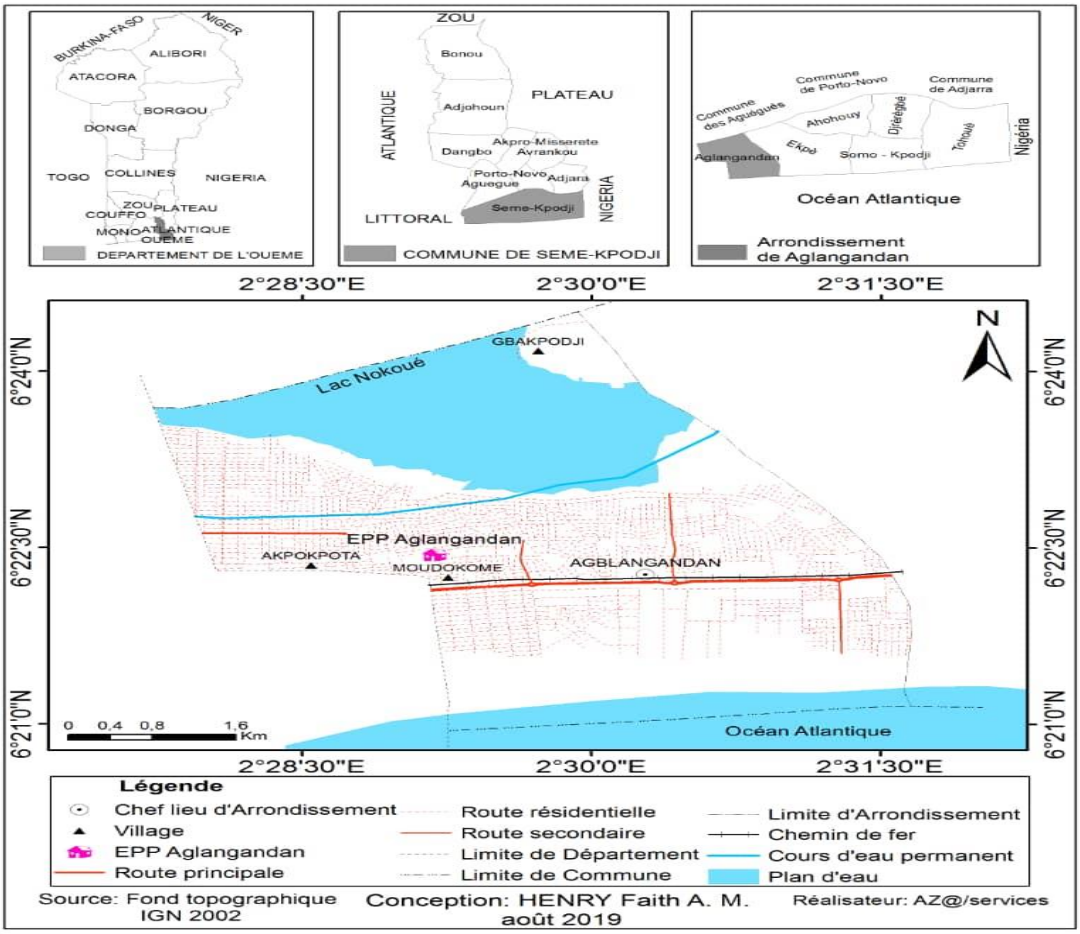


Figure1. *Geographic map indicating the sampling area*

Handwashing compliance among schoolchildren, teachers and saleswomen

We performed direct compliance using the WHO handwashing procedures (2006) in six steps. Step 1: wet hands; Step 2: soap; Step 3: rub; Step 4: clean the backs of the hands between fingers thumb and nails; Step 5: rinse; Step 6: dry (duration of the procedure 40-60S)

Bacteriological quality of the washed hands

Samples were taken by swabbing from both hands for each actor in the school environment. Those samples were collected before and immediately after washing the hands. A single swab took into account both hands. One hundred and twenty-four (62 before and 62 after washing hands) samples were collected. After collection, samples were immersed in sterile Heart Brain infusion and incubated at 37°C for 24 hours. After incubation, the broths were inoculated on selective agar medium. Thus, rod-shaped bacteria (bacilli) was inoculated on Eosin Methylene Blue (EMB) agar whereas cocci were on Chapman agar. The identification of bacteria was done using the Leminor gallery (urea-indole, Kligler-Hajna agar, mannitol-mobility agar and Simmons Citrate agar for gram-negative bacilli and the catalase, indole and Dnase test).

Susceptibility to antibiotics

The disc diffusion method was used to investigate the susceptibility of isolates to fifteen antibiotics (Oxoid). The results were interpreted according to the recommendations of the antibiogramm committee of the French Society of Microbiology [9]. The seven (7) antibiotics used for gram-positive strains were oxacillin (OX 15 µg), ofloxacin (OFX 30 µg), ciprofloxacin, gentamicin (G 10 µg),

vancomycin (VA 30 µg), sulfamethoxazole-trimethoprim (SXT 23.75 µg) and erythromycin (E 15 µg). The seven antibiotics used for gram-negative bacteria were ofloxacin (OFX 30µg), ciprofloxacin, gentamicin (G 10 µg), sulfamethoxazole-trimethoprim (SXT 23.75 µg), tetracycline, nalidixic acid (NA 30 µg) and cephalothin (KF 30 µg).

Data analysis

The averages values were calculated with an MS Excel 2016 spreadsheet. Graph Pad Prism 8 was used to determine significant differences at the 5% level ($p < 0.05$) between the calculated averages.

3. RESULTS

3.1 Handwashing compliance

The table I reveals a dominance of female (73.62%).

TableI. *Distribution of the target population*

Target population	Number	Partners	Proportion of partners (%)
Sexes			
Male	234	96	41,02
Female	180	134	73,62
School stakeholders			
Schoolchildren	390	210	53,84
Teachers	18	13	72,22
Saleswomen	8	7	75

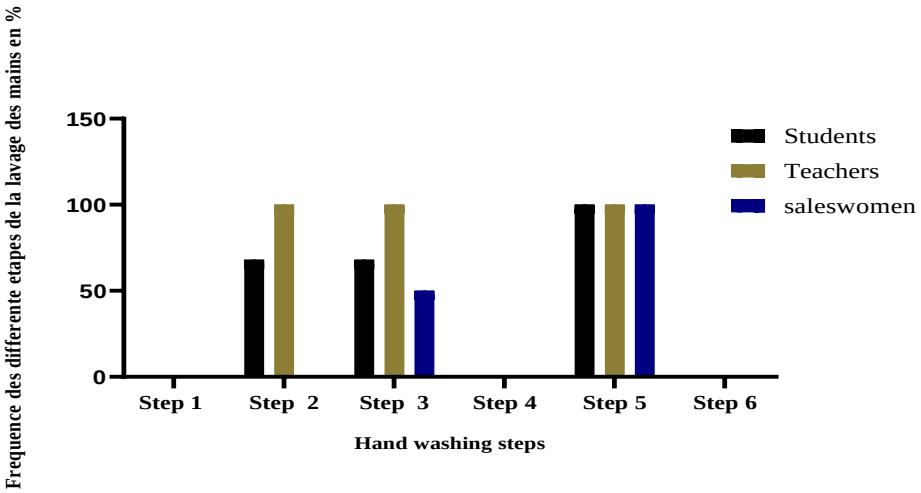
It emerges from the analysis of the table II that 33.48% of the actors of the school environment observed simple hand hygiene including 29.56% of schoolchildren and 3.04% of teachers observed hand hygiene before eat. We note that 0.87% of saleswomen observed hand hygiene before selling food to students.

Table II. *Distribution of Participants observing hand hygiene*

School stakeholders	Number	Observant	Percentage	*P-value*
Schoolchildren	210	68	29.56	*P=0.3789*
Teachers	13	7	3.04	
Saleswomen	7	2	0.87	
Total	**230**	**77**	**33.48**	
P-value	*P=0.2114*			

3.2 Hand washing compliance in different stages

Figure 2 shows the frequencies of the different stages of hand washing among schoolchildren, teachers and saleswomen. According to our study, the actors in the school environment studied did not respect steps 1 (wetting the hands), 4 (cleaning the backs of the hands between the fingers) and 6 (drying the hands).



Step 1: wet hands; Step 2: soap; Step 3: rub; Step 4: clean the backs of the hands between fingers thumb and nails; Step 5: rinse; Step 6: dry.

Figure2. *Frequencies of the different hand washing steps among schoolchildren, teachers and saleswomen.*

Microbiological quality of the hands

Figure 3 shows the percentage of bacteria isolated before handwashing in schoolchildren, teachers and vendors. It can be seen from this figure that there is presence of bacteria in the hands of the actors of the Agblangandan primary school environment. The presence of these bacteria is more remarkable in schoolchildren. *Staphylococcus aureus* are the dominant bacteria on hands before hand washing. Among the strains isolated, 158 species were identified in different proportions, namely: *S. aureus* (31.02%) *Staphylococcus epidermidis* (11.23%), *Escherichia coli* (12.83%), *Klebsiella pneumoniae* (24.59%), *Pseudomonas aeruginosa* (14.44%) and *Serratia marcescens* (8.87%).

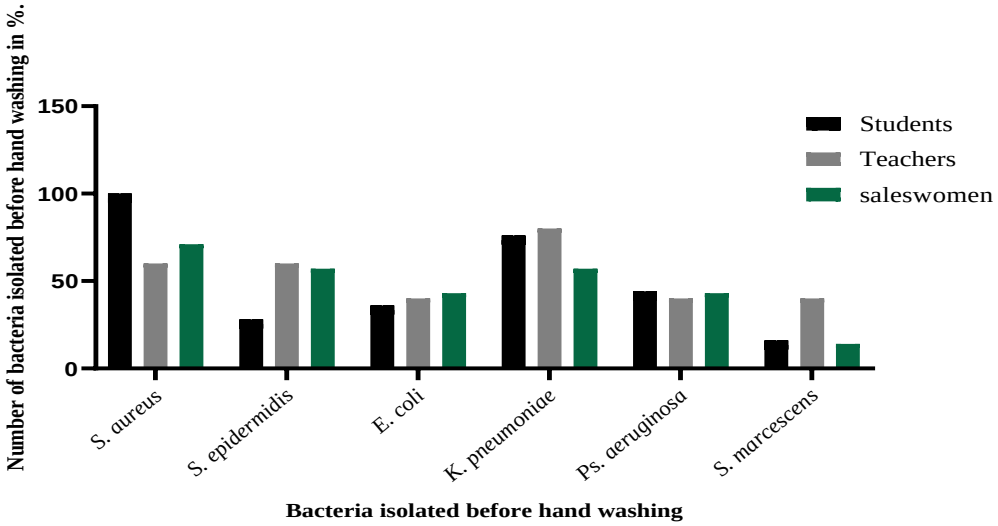


Figure3. *Percentage of bacteria isolated before hand washing in schoolchildren, teachers and saleswomen.*

The analysis of the percentage of bacteria isolated after hand washing among schoolchildren, teachers and saleswomen shows that there is an unremarkable decrease in the bacterial load of the hand among actors in the school environment of the Agblangandan primary school (Figure 4). Among the strains isolated, 122 species were identified in different proportions, namely: *S. aureus* (31.97%), *Staphylococcus epidermidis* (20.49%), *Escherichia coli* (0.82%), *Klebsiella pneumoniae* (20.49%), *Pseudomonas aeruginosa* (19.67%) and *Serratia marcescens* (6.56%). The presence of these bacteria is more remarkable in schoolchildren (107 of the 122 isolated bacteria).

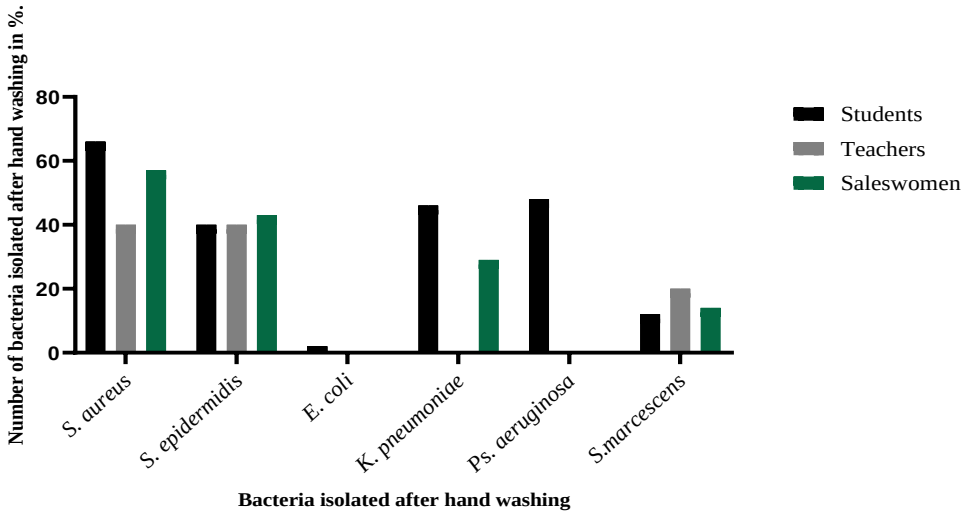


Figure4. *Percentage of bacteria isolated after hand washing in schoolchildren, teachers and saleswomen.*

3.3 Bacteriological Characteristics of the Water

Bacteriological analysis showed that *S. aureus* is dominant in water at Agblangandan primary school (Table III)

Table III: *Proportion of microorganisms isolated from water at Agblangandan primary school in May 2019*

Isolated bacteria	Water samples						Total %
	Well water		Rinse water		Reservoir water		
	N	%	N	%	N	%	
S. aureus	2	100%	2	100%	2	100%	100
K. pneumoniae	2	0%	2	100%	2	100%	67
P. aeruginosa	2	0%	2	100%	2	100%	67
E. coli	2	0%	2	100%	2	100%	67
Staphylococcus epidermidis	2	100%	2	100%	2	100%	100

3.4 Sensitivity of Gram-negative strains isolated to antibiotics

The results show that 44.35% of the Gram-negative strains are resistant to the tested antibiotics and 55.65% of the Gram-negative strains are sensitive to the tested antibiotics. Thus, figure 5a shows the resistance of the *E. coli* strains tested. Globally, the analysis of this figure shows that 49.26% of *E. coli* strains are resistant to the tested antibiotics. Various proportion of resistance to cephalotin (100%), sulfamethoxazole-trimethoprim (96.55%) and Tetracycline (72.42%) were recorded. According to figure5c, 43.40% of the isolated *Pseudomonas aeruginosa* are resistant to tested antibiotics in general. Various resistance proportion were recorded for sulfamethoxazole-trimethoprim (96.55%), cephalotin (100%) and tetracycline (83.64%). For *Klebsiella pneumonia* isolates, it was recorded a global resistance of 45.46%. For those strains, a resistant to sulfamethoxazole-trimethoprim (100%), cephalotin (100%) and to tetracycline (84.42%) was recorded and displays in the figure 5b. The resistance profile of *Serratia marcescens* was shown in the figure 5d.

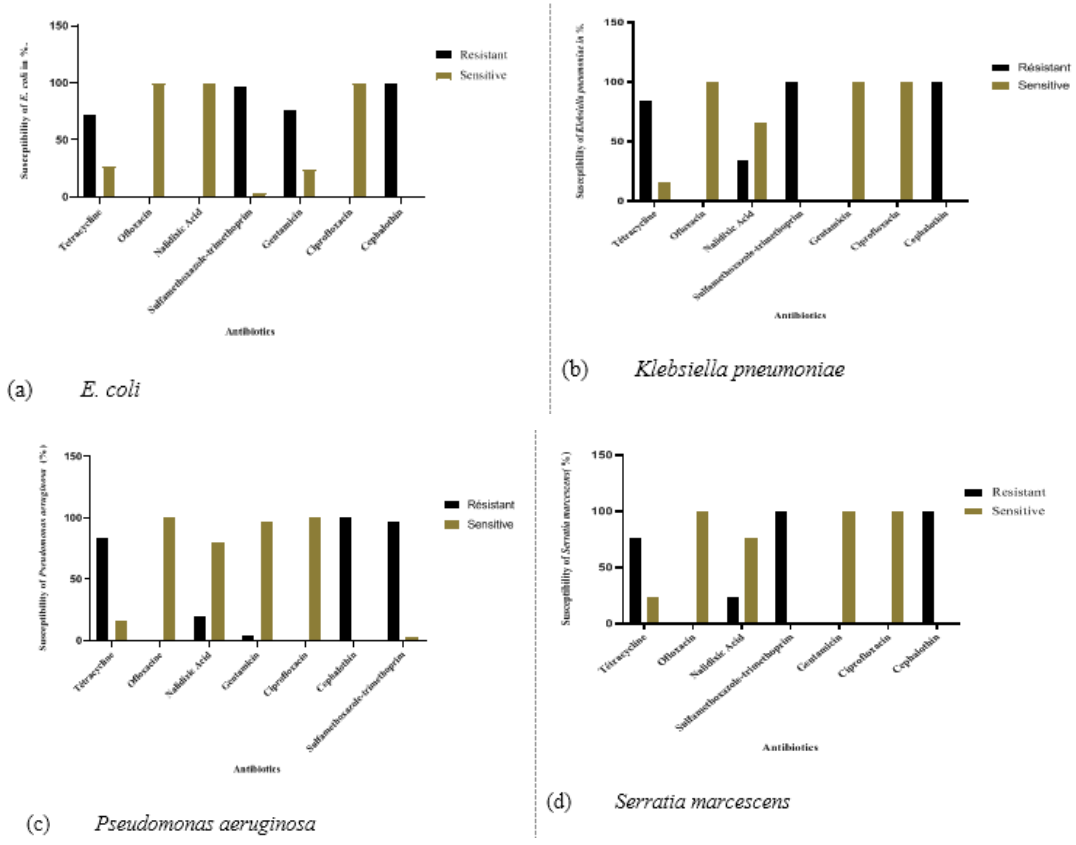


Figure5. *Sensitivity of the Gram-negative strains isolated to the seven tested antibiotics*

3.5 Antibiotic sensitivity of isolated *S. aureus* strains

Considering the resistance of *Staphylococcus aureus*, globally, 42.31% are resistant to the tested antibiotics. More than 98% of the isolated *S. aureus* were resistant to oxacillin (Figure 6).

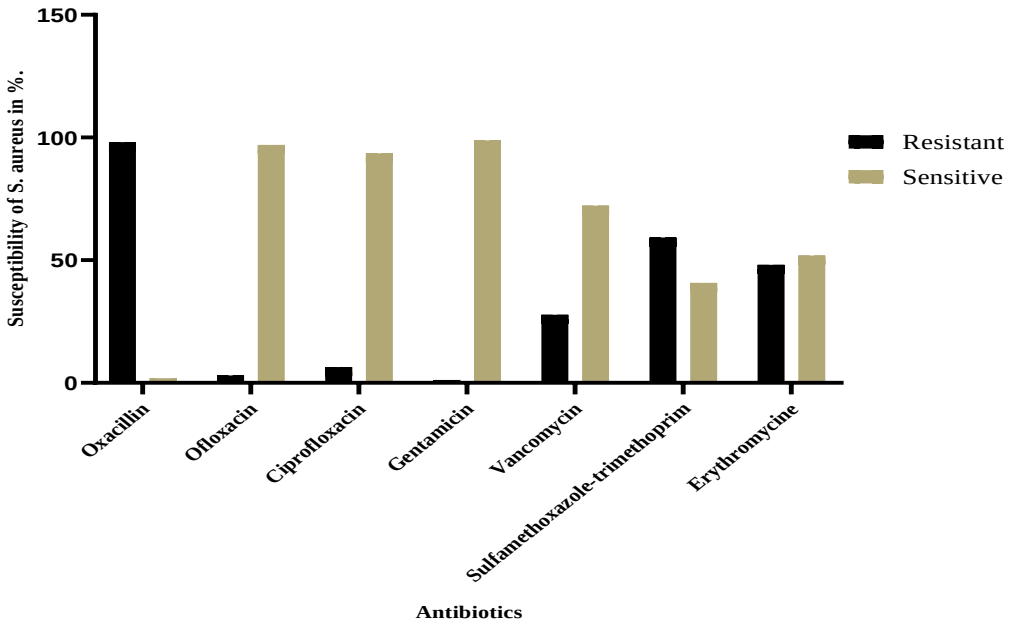


Figure6. *Sensitivity of the S. aureus strains isolated to the seven tested antibiotics*

4. DISCUSSION

This study is part of an approach aimed at assessing the level of compliance with hygiene rules in school environment. The compliance rate for handwashing by studied actors is 33.47%. This could be explained by the lack of handwashing device in Agblangandan public primary school that would constitute an obstacle to the observance of handwashing. Structural factors, including having accessible time, opportunities and facilities influence the likelihood of handwashing becoming routine. Norms of social behavior are also an integral part of the structure and are adopted and reproduced by individuals [15]. Being part of a structure where handwashing is demonstrated and encouraged can positively influence handwashing practices. In addition, good education and information could help hand washing being improved in schools. Therefore, through providing clean and attractive facilities with pleasant soap and efficient hand drying options, in classrooms, teachers and students do not need to leave the classroom to wash their hands [18]. According to WHO, steps 1, 4 and 6 of hand washing are not well understood by the studied actors. The most common mistakes are getting your hands wet, cleaning between the fingers, thumb and nails. Fonton [14] made the same observation among nursing staff where only indications 1, 3 and 5 are sometimes respected. A study in Kenya found that less than 2% of schoolchildren washed their hands with soap, which was available in less than 5% of schools [10]. An assessment in India found that handwashing before eating in schools was much more common in districts with WASH in schools programs than in reference districts. Nevertheless, 2% or less of children used soap, which considerably reduced its effectiveness [11]. UNICEF estimates that 50% of deaths from diarrhea and 25% of deaths from acute respiratory illnesses could be avoided if handwashing with soap became standard practice before eating and after using toilets [12]. The presence of potentially pathogenic bacteria on the hands of teachers, schoolchildren and saleswomen is a public health problem. Indeed, good hand hygiene is an important infection control measure because person-to-person contact, including through the hands, is a common mode of gastrointestinal and respiratory infections transmission [16]. Hand hygiene is important in elementary schools to prevent the infectious diseases spread and is a key infection control measure recommended during a pandemic [17]. Improving hand hygiene to reduce the infections transmission could reduce teacher and student absenteeism in schools, and could also prevent secondary infections in the wider community, reduce health service costs and alleviate the burden. Burden on families, some of whom may need to take time away from work to care for children.

Identification of Gram-negative bacilli revealed the presence of *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Serratia marcescens*. Concerning the Gram-positive cocci, they are composed of *Staphylococcus aureus* and *Staphylococcus epidermis*. These species

would come from hands transient flora contamination. This polymorphic flora is composed of potentially pathogenic, skin and tract digestive microorganisms. This can come from contaminated material or even contact with colonized or infected individuals. The presence of *Escherichia coli* and *Staphylococcus epidermis* among the germs detected poses a hygiene problem among the studied actors. Indeed, according to Cabillic [5], *Escherichia coli* is the witness of fecal contamination. *Staphylococcus aureus* tops the list of isolated species. This could be explained by the fact that *Staphylococcus aureus* is present on human skin. Analyzes performed after handwashing showed that less than 13% of schoolchildren, teachers and saleswomen had their bacterial loads reduced respectively after handwashing. These results show that among the large number of studied actors, hand washing had no impact on the bacterial loads carried them. This could be due to the way hands are wash and the water quality. As the water used by the actors was contaminated with bacteria, found in the hands, the various failed steps can explain this small reduction in the microbial load. Likewise, bacteriological analysis of the six water samples showed a variable rate of contamination by *S. aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Klebsiella pneumoniae*. This poor water quality could explain the contamination level of hands observed after washing. *E. coli* associated with coliform bacteria is the only indicator that unequivocally represents of animal and/or human fecal contamination according to Edberg et al. [13]. Its detection in water should be considered to reflect the possible presence of enteric pathogenic microorganism's origin. In fact, *E. coli* is considered as the best indicator of fecal contamination in water. Bacteria isolated from hands are found in water. This could be explained by the presence of these bacteria after hand washing confirming the overall poor hygiene. However, we noted a significant decrease in Gram-negative bacilli compared to Gram-positive cocci after hand washing. This state of affairs could be linked to the quality of the soap used by these actors. Indeed, this soap would have more effect on the wall of Gram-negative bacilli than on that of Gram-positive cocci. School authorities should therefore ensure the quality of the soap used by schoolchildren for satisfactory hand washing. Good hand washing requires mastery of technique by those working in the school environment.

The frequent hospitalizations of these schoolchildren in the Agblangandan health center relate to infections. According to Goldmann [16], good hand hygiene is an important infection control measure because person-to-person contact is a common mode of gastrointestinal and respiratory infections transmission. Respiratory infections (48%) and infectious intestinal diseases (29%) are responsible of primary care visits in children aged 0 to 14 years [19]. The antibiotic sensitivity study revealed that all of the strains isolated are multi-resistant to most of the antibiotics tested. As the school is in a community, this multi-resistance of bacteria can be due to the diversity of the school actors, the mixing of school actors, and the poor quality of the water and the lack of public hygiene.

5. CONCLUSION

This study on the quality of hand washing of school actors in the Agblangandan primary school reveals the insufficient of infrastructure and poor knowledge of the steps of hand washing. This situation is a barrier to adherence to hand washing and indicate a high infectious risk in the school environment. In addition, the presence of potentially pathogenic bacteria with multi-resistant profile confirms a poor hygiene level and suggests an identical situation for other schoolchildren living the same realities. However, reducing these risks requires better involvement of stakeholders in the school environment, it is essential to ensure compliance with hygiene rules, particularly the correct hands washing in order to reduce manual transmission. These results will help an orientation on antibiotic therapy aiming of improving the care quality in all health establishments.

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