Global Advanced Research Journal of Microbiology (ISSN: 2315-5116) Vol. 9(4) pp. 059-068, August, 2020 Issue.
Available online http://garj.org/garjm


*Full Length Research Paper*

# Epidemiological and bacteriological aspects of skin lesions in pupils attending primary schools in central Côte d'Ivoire (Bouaké)

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Accepted 07 August, 2020

**In Sub-Saharan Africa, skin infections mainly affect children. Among this, cutaneous anthrax is known to affect domestic animals and young children might have contact with infected animals or contaminated animal products. The objective of this study was to describe the epidemiological, bacteriological aspects of skin lesions and to assess the risk of acquiring cutaneous anthrax in the school environment in Bouaké. It is a cross-sectional descriptive and analytical study. Epidemiological data were collected using a simple questionnaire. Skin lesions were analyzed using conventional bacteriological methods. Antimicrobial susceptibility of isolates was tested using the Kirby-Bauer technique according the Antibiogram Committee's recommendations of the French Society of Microbiology 2019. Of the 3174 schoolchildren, 1220 (38.43%) had skin lesions. 325 (26.63%) schoolchildren were included in the study and had a mean age of 9 years (± 5) with a sex ratio of M/F at 1.65. Young schoolchildren aged 5 to 10 years were the most affected (76.62%). The majority had regular contact with domestic animals (64.31%). The rate of hand washing after defecation was 41.38%. Skin lesions were located on the lower limbs (91.69%), with superficial lesions (88.79%), ulceration (81.03%) and trauma (79.40%) being the most common. Culture of swabs was positive in 85.29% of cases and 277 bacterial strains were identified. The bacteria identified were mainly *Staphylococcus aureus* (71.84%), and *Streptococcus* spp. (6.50%). *Bacillus* spp. was observed rarely, and neither classic *B. anthracis* nor the atypical *B. cereus* biovar *anthracis* were identified. The resistance phenotypes reported in *Staphylococcus aureus* were PASE (95%), MRSA (34%), and VAN-R (15%).The high prevalence of MRSA requires also health surveillance in these schools. Our results can be used in the management or antibiotic treatment of skin infections.**

**Keywords:** Skin lesions - Staphylococcus aureus- MRSA - schoolchildren - Côte d'Ivoire (Bouake).

## INTRODUCTION

In Sub-Saharan Africa, skin infections are very frequent among children under 15 years of age, and represent the 3rd cause of hospital visits after malaria and diarrheal diseases (Emodi et al., 2010; Hay et al., 2014). Indeed, 30% of consultations in pediatrics wards are associated to skin disease (Cohen, 2007) correlated with precarious living and hygiene conditions (Adégbidi et al., 2014). Skin infections thus remain a major public health problem, especially in Africa (Mahé et al., 2003).These lesions are most often observed on healthy and irritated skin or on pre-existing injuries such as burns, traumatic lesions and tumours (Darre et al., 2015). Many complementary factors such as microbial agents reinforce their infection (Niamba, 2007). Skin infections of bacterial origin are one of the factors of students' failures because of the impact on their moral and physical health (Vachée et al., 2009). Previous studies have shown that bacterial causes involved were representedby bacteria of the genera *Staphylococcus* and *Streptococcus* ranking first (Ray et al., 2013; Lorette et al., 2009). In Côte d'Ivoire, cases of skin lesions are reported every year but adequate management is rarely described. Despite the clinical manifestations of skin lesions in children pupils, epidemiological data are non-existent. Similarly, no data about the prevalence of cutaneous anthrax are available. The objective of this study was to describe the epidemiological and bacteriological aspects of skin lesions among schoolchildrenin Bouaké.

## MATERIAL AND METHODS

### Period, site and type of study

The study was conducted from November 2018 to May 2019 in five primary schools in Bouaké, Côte d'Ivoire. Bouaké is located in central Côte d'Ivoire at latitude 7°69 N and longitude 5°03 W and 350 km from North of the economic capital, Abidjan. It is an important commercial crossroads for livestock and other food and industrial products. Here, we present a cross-sectional descriptive and analytical study on the bacterial etiology of skin lesions reported in 5 primary schools. The choice of schools was made according to their proximity to the farming areas where schoolchildren are in regular touch with domestic or farm animals such as dogs, cattle, sheep and chicken. The inclusion criteria were: schoolchildren under 15 years of age, regardless of sex, with skin lesion(s) in the form of an open or closed wound with palpable liquid collection (suppurative or serous). From all participating pupils an informed consent of a parent or legal guardian was obtained prior to sampling activities.

### Samples and epidemiological data collection

Three workstations were set up in each school: the first workstation was used to identify schoolchildren with at least one skin lesion, the second workstation to include eligible cases and the third workstation to collect skin lesion samples. The pupils included were interviewed using a simple questionnaire by a medical doctor. The data collected included sex, age, area of residence, activity outside school, hygiene measures and description of skin lesions. After the interview, sampling consisted of swabbing open lesions; in case of closed lesions with fluid collection, a syringe puncture was performed to aspirate the fluid by a pediatrician. The swabs and syringes were sent in a cooler within 4 hours to the laboratory for bacteriological analyses, which were carried out at the Bacteriology-Virology laboratory of Bouaké Teaching Hospital.

### Bacteriological analysis

Swabs of skin lesions were analyzed using conventional bacteriological techniques: direct examination including Gram stain, catalase and coagulase tests, respiratory type test, microscopy of capsules and bacterial culture carried out on non-selective as well as selective agar plates incubated at 37°C for 18-24 hours. The agars used were Columbia agar (Bio-Rad, Marmes-la Coquette, France) enriched with 5% fresh sheep blood, Chapman agar (Bio-Rad, Marmes-la Coquette, France), Eosine Methylene blue and MacConkey agars (Bio-Rad, Marmes-la Coquette, France) for Enterobacteriaceae, Columbia blood agar and Cereus Ident agar (*Bacillus cereus/Bacillus thuringiensis* Chromogenic Plating Medium, R & F Products, Downers Grove, USA) for detection of *Bacillus cereus* group members (Klee et al., 2006). After incubation, suspect colonies were identified by the Lancefield serum agglutination test with the Pastorex Strept Kit (Bio-Rad, Marmes-la Coquette, France, ref: 61721) for *Streptococcus* strains and the research for free staphylocoagulase with Rabbit plasma (Bio-Rad, Marmes-la Coquette, France, ref: 56352) then for bound staphylocoagulase with the Pastorex Staph Kit (Bio-Rad, Marmes-la Coquette, France ref:56356) for *Staphylococcus* strains. The identification of Enterobacteriaceae was performed using the reduced rack of Leminor highlighting the biochemical characters of the isolated strains and that of the genus *Bacillus* by the Api50CHB test kit (BioMérieux, Lyon, France, ref: 50430). The determination of the sensitivity of identified strains to the usual antibiotics was carried out by the Mueller-Hinton agar diffusion method. The inhibition diameters were interpreted according to the criteria of French Committee

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for Antibiogram (CA-SFM 2019). Different phenotypes were researched : the PASE phenotype was *S. aureus* resistant to1µg penicillin G disc with an inhibition diameter < 26 mm, *Staphylococcus* resistance to methicillin was investigated using a 30µg cefoxitin disc and strains with an inhibition diameter < 22 mm were considered methicillin resistant *S. aureus* (MRSA),the resistance of Staphylococci to vancomycin was investigated using 30 µg vancomycin disc and strains of *S. aureus* with an inhibition diameter less than 15 mm were considered resistant to vancomycin (VAN-R). Two other phenotypes of *S aureus* like resistant to 3 antibiotics: kanamycin, tobramycin and gentamycin (KTG) and resistant to macrolide-lincosamide-streptogramin b (MLSb) were also observed. The ESBL phenotype of strains of Enterobacteriaceae was studied using the amoxicillin/clavulanic acid/ third generation cephalosporin synergy test. The appearance of a champagne cork image between the antibiotic discs indicates ESBL production. Bacterial strains resistant to more than three families of antibiotics have been classified as multi-resistant bacteria (MRB). Bacteria sensitive to all the antibiotics tested were referred to as wild type bacteria. The antibiotics used in this study are : Beta-lactam : penicillin G (1µg), cefoxitin (30µg), amoxicillin + clavulanic acid (20/10µg), ampicillin (10µg), cefepime (5µg), ceftazidime (10µg), aztreonam (30µg), imipenem (10µg), meropenem (10µg) and ceftriaxone (30µg); Aminosides: kanamycin (30µg), amikacin (30µg), gentamycin (10µg/30µg), tobramycin (10µg) and streptomycin (500µg); Macrolides and related: erythromycin (15µg), clindamycin (2µg), linozolid (10µg) and pristinamycin (15µg), Sulfonamides: trimethoprim-sulfamethoxazole (1.25/23.75µg); Phenicols : chloramphenicol (30µg) ; Fluoroquinolones : ciprofloxacin (5µg), levofloxacin (5µg), norfloxacin (10µg) andofloxacin (5µg); Glycopeptides: vancomycin (30µg/5µg) andteicoplanin (30µg);Cyclines: tetracycline (30µg) and minocycline (30µ); Polymyxins: colistin (10µg) and otherantibiotics : rifampicin (5µg); fusidic acid (10µg); fosfomycin (200µg); bacitracin and optohine.

The data wereanalyzed using Epi-Info 7 version 7.1.5.2 (2015); quantitative variables were presented as means and standard deviations and qualitative variables as proportions.

## RESULTS

### Socio-demographic characteristics of pupils interviewed

Out of a total of 3174 schoolchildren in the different primary classes, 1220 (38.43%) schoolchildren had skin lesions and 325 (26.63%) were included in the study. Their mean age was 9 years with extremes of 5 years and 15 years. The most affected schoolchildren were aged 5 to 10 years (76.62%). More than half (61.68%) were males with a sex ratio of 1.65. The distribution of students by area of residence revealed 89.72% of pupils living in urban areas. Most students (77.53%) were playing games like sports after the school. But 64.31% were in regular touch with domestic or farm animals. Compliance with some hygiene rules was also checked; more than half (69.16%) took an individual shower daily. Drinking water was used in 71.96% of cases, while hand washing before and after meals and after defecation was done in 55.14% and 41.38% of cases respectively (Table 1).

### Characteristics of the skin lesions observed

The skin lesions were generally due to skin trauma (79.44%). They were ulcerative (81.03%), pustular (13.80%), necrotic (3.45%) and vesicular (1.72%) with acute (58.30%), subacute (29.12) and chronic (12.58%) like evolutions of wound according the duration of the healing and the complication (0-10 days for acute, 10-20 days for subacute and from 21 days for chronic). The lesions were mainly localized on the lower limbs (91.69%), then the upper limbs (7.38%) and the head (0.93%); they were generally superficial (88.79%). Associated clinical signs were pain (55.14%), pruritus + pain (19.63%), pruritus (16%) and swelling + pain (5.61%). Treatment of these lesions was reported in 64.30% of cases (Table 2).

### Bacteriological data

A total of 340 swabs of skin lesions from the 325 included pupils were streaked on to specific agars. Culture of swabs was positive in 85.29% of cases (290/340) with co-infection in 36.47% of cases (124/340) and 277 bacterial strains were isolated (Table 3). The most frequently isolated bacterial species were Gram-positive Cocci (86.28%) with *Staphylococcus aureus* (71.84%) followed by Coagulase-Negative Staphylococci CNS (7.94%) and *Streptococcusspp*. (6. 50%). Gram-negative bacilli were represented by non-fermenting bacilli (6.13%), *Alcaligenes spp*. (5.05%) and *Acinetobacter spp*. (1.08%) and Enterobacteriaceae (5.41%), *Enterobacter cloacae* (3.97%) and *Klebsiella pneumoniae* (1.44%). Gram-positive Bacilli in particular *Bacillus spp*. were isolated in a very small proportion (2.18%). The *Bacillus* species identified were *Bacillus circulans* (1.44%), *Bacillus megaterium* (0.36%) and *Bacillus subtilis* (0.36%). *Bacillus anthracis* and *Bacillus cereus* biovar *anthracis* were not isolated, which could be confirmed by the lack of bacterial growth on Cereus Ident agar.

### Antibiotic susceptibility of isolated bacterial strains

Concerning the sensitivity of the bacteria to the antibiotics tested, data are summarized in table 4. Strains of *S. aureus* (n= 199) were resistant to penicillin G (95%),

**Table 1: Distribution of schoolchildren by socio-demographic characteristics**

| Parameter | Number of students (n=325) | Percentage (%) |
|---|---|---|
| **Sex** | | |
| Male | 201 | 61,68 |
| Female | 124 | 38,32 |
| **Age group** | | |
| [5-10 years [ | 224 | 68,92 |
| [11-15 year old] | 101 | 31,08 |
| **Residence area** | | |
| Urban | 292 | 89,72 |
| Rural | 33 | 10,28 |
| **Regular contact with domestic animals** | | |
| Touching | 209 | 64,31 |
| Contactless | 116 | 35,69 |
| **Work outside of school** | | |
| Games | 252 | 77,53 |
| Housework | 73 | 22,47 |
| **Hygiene measures** | | |
| Individual shower | 225 | 69,16 |
| Use of drinking water | 234 | 71,96 |
| Washing hands before and after eating | 179 | 55,14 |
| Hand washing after defecation | 141 | 41,38 |

**Table 2: Distribution of schoolchildren skin lesions according to clinical and therapeutic characteristics**

| Parameter | Number of students n=325) | Percentage (%) |
|---|---|---|
| **Context of the lesions** | | |
| Trauma | 258 | 79,4 |
| Healthy skin | 36 | 11,07 |
| Pre- existing injury | 31 | 9,53 |
| **Types of injury** | | |
| Ulceration | 294 | 90,46 |
| Pustule | 14 | 4,31 |
| Vesicle | 12 | 3,69 |
| Necrotic | 5 | 1,54 |
| **Evolution** | | |
| Acute | 173 | 53,23 |
| Subacute | 108 | 33,23 |
| Chronic | 44 | 13,54 |
| **Depth of lesions** | | |
| Superficial | 289 | 88,92 |
| Deep | 36 | 11,08 |
| **Associated clinical sign** | | |
| Pain | 203 | 62,46 |
| Pruritus | 57 | 17,54 |
| Pruritus+ pain | 44 | 13,54 |
| Fever | 10 | 3,07 |
| Pain + swelling | 6 | 1,85 |
| None | 5 | 1,54 |

**Table 2:** Continue

| | | |
|---|---|---|
| **Treatment received** | | |
| Local | 191 | 58,77 |
| None | 116 | 35,7 |
| Local +general | 15 | 4 ,61 |
| General | 3 | 0,92 |

**Table 3: Distribution of bacterial species isolated from skin lesions by bacterial group**

| Bacterial species | strains (n=277) | Percentage (%) |
|---|---|---|
| **Gram positive cocci (n=239)** | | |
| *S. aureus* | 199 | 71,84 |
| Coagulase – Negative Staphylococci | 22 | 7, 95 |
| *Group A Streptococcus* | 8 | 2,9 |
| *Group C Streptococcus* | 3 | 1,08 |
| *Group G Streptococcus* | 5 | 1,8 |
| *Non –groupable streptococcus* | 2 | 0,72 |
| **Enterobacteriaceae Gram- negative bacilli** | | |
| *Klebsiella pneumoniae* | 4 | 1,44 |
| *Enterobacter cloacae* | 11 | 3,97 |
| **Non- fermentative Gram-negative bacilli fermentaires** | | |
| *Alcaligenes* spp. | 14 | 5,05 |
| *Acinetobacter* spp. | 3 | 1,08 |
| **Gram –positive bacilli** | | |
| *Bacillus circulans* | 4 | 1,44 |
| *Bacillus megaterium* | 1 | 0,36 |
| *Bacillus subtilis* | 1 | 0,36 |

tetracycline (85%), fluoroquinolones such as norfloxacin (77%), ofloxacin (72%), ciprofloxacin (68%) and levofloxacin (62%). They were resistant to all macrolide and related molecules tested in proportions of (57-67%). They were sensitive to fosfomycin (98%), trimethoprim-sulfamethoxazole (97%), fusidic acid (96%), rifampicin (95%), chloramphenicol (87%) and vancomycin (85%). Resistance phenotypes observed were PASE (95%), MRSA (34%), KTG (17%), MLSb Inductible (4%) and VAN-R (15%) (Table 5). Coagulase-Negative Staphylococci strains (n=22) were 100% resistant to penicillin G and 57% resistant to cefoxitin. Most of these strains were also resistant to tetracycline (86%), erythromycin (57%) and ofloxacin (57%). They were sensitive to Linezolide (86%), chloramphenicol (86%), norfloxacin (86%), rifampicin (86%) and fusidic acid (86%). Aminosides (gentamycin,

**Table 4: Sensibility of bacteria to the antibiotics tested**

| Antibiotics | *S. aureus* (n=199) | | *SCN* (n=22) | | *Streptococcus* spp. (n=18) | | *K. pneumoniae* (n=4) | | *E. cloacae* (n=11) | | *Acinetobacter* spp. (n=3) | | *Alcaligene* spp. (n=14) | | *Bacillus* spp. (n=6) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S |
| **Beta-lactam** | | | | | | | | | | | | | | | | |
| Penicillin G | 189(95%) | 10(5%) | 22(100%) | 0(0%) | 0(0%) | 18(100%) | - | - | - | - | - | - | | | 6(100%) | 0(0%) |
| Cefoxitin | 68(34%) | 131(66%) | 10(43%) | 12(57%) | - | - | - | - | - | - | 0(0%) | 3(100%) | 0(0%) | 14(100%) | - | - |
| Amoxicillin + Clavulanic acid | - | - | - | - | - | - | 1(25%) | 3(75%) | 0(0%) | 11(100%) | - | - | | | - | - |
| Ampicillin | - | -- | - | - | - | - | 1(25%) | 3(75%) | 3(27%) | 8(73%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| Cefepime | - | - | - | - | - | - | 1(25%) | 3(75%) | 2(18%) | 9(82%) | 0(0%) | 3(100%) | 2(15%) | 12(85%) | 0(0%) | 6(100%) |
| Ceftazidime | - | - | - | - | - | - | 1(25%) | 3(75%) | 2 (18%) | 9(82%) | - | - | - | - | 0(0%) | 6(100%) |
| Aztreonam | - | - | - | - | - | - | 0(0%) | 4(100%) | 1(10%) | 10(90%) | - | - | - | - | - | - |
| Imipenem | - | - | - | - | - | - | 1(25%) | 3(75%) | 1(10%) | 10(90%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| Meropenem | - | - | - | - | - | - | 0(0%) | 4(100%) | 0(0%) | 11(100%) | - | - | - | - | - | - |
| Ceftriaxone | - | - | - | - | - | - | 0(0%) | 4(100%) | 3(27%) | 8(73%) | 0(0%) | 3(100%° | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| **Aminosides** | | | | | | | | | | | | | | | | |
| Kanamycin | 36(18%) | 163(82%) | 0(0%) | 22(100%) | - | - | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 1(7%) | 13(93%) | 0(0%) | 6(100%) |
| Gentamycin | 34(17%) | 165(83%) | 0(0%) | 22(100%) | 2(12%) | 16(88%) | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| Tobramycin | 38(19%) | 161(81%) | 0(0%) | 22(100%) | - | - | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Streptomycin | - | - | - | - | 0(0%) | 18(100%) | - | - | - | - | - | - | - | - | - | - |
| **Macrolides** | | | | | | | | | | | | | | | | |
| Erythromycin | 86(43%) | 113(57%) | 12(57%) | 10(43%) | 5(28%) | 13(72%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Clindamycine | 76(38%) | 123(62%) | 6(29%) | 16(71%) | 2(12%) | 16(88%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Linezolid | 74(37%) | 125(63%) | 3(14%) | 19(86%) | 4(22%) | 14(78%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |

tobramycin and kanamycin), vancomycin and fosfomycin were the antibiotics active on all strains isolated. The MRB resistance phenotype represented 13% of identified strains. Strains of *Streptococcusspp*. (n=18) were 83% resistant to the cyclins (tetracycline and minocycline) tested. Most *Streptococcus spp*. were sensitive to gentamycin (88%), macrolides with clindamycin (88%). Penicillin G, streptomycin, trimethoprim sulfamethoxazole, vancomycin and rifampicin were active on all strains isolated. *Klebsiella pneumoniae* and *Enterobacter cloacae* strains were resistant to Betalactam antibiotics with percentage ranging of 0 to 27%.The antibiotics such as kanamycin and gentamycin, chloramphenicol, fluoroquinolones (ciprofloxacin, levofloxacin and ofloxacin) and colistin were 100% actives on all *Enterobacter cloacae* strains. In addition, trimethoprim-sulfamethoxazole was active on all strains of *Klebsiella pneumoniae.*

Among the non-fermentative Gram-negative Bacilli, strains of *Acinetobacter spp*. did not show resistance to the molecules tested. Two of the strains of *Alcaligenes spp*. were resistant to cefepime, kanamycin, levofloxacin and ofloxacin but all strains were susceptible to Betalactam (cefoxitin, ampicillin, imipenem and ceftriaxone), gentamicin, trimethoprim-sulfamethoxazole, chloramphenicol and ciprofloxacin. Strains of *Bacillus spp*. were resistant to penicillin G but sensitive to the other antibiotics tested.

**Table 4: (continued) Sensibility of bacteria to the antibiotics tested**

| Antibiotics | *S. aureus* (n=199) | | *SCN* (n=22) | | *Streptococcus* spp. (n=18) | | *K. pneumoniae* (n=4) | | *E. cloacae* (n=11) | | *Acinetobacter* spp. (n=3) | | *Alcaligene* spp. (n=14) | | *Bacillus* spp. (n=6) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S |
| Pristinamycin | 66 (33%) | 133(67%) | 0(0%) | 22(100%) | - | - | - | - | - | - | - | - | - | - | - | - |
| **Sulfamides** | | | | | | | | | | | | | | | | |
| Triméthoprime-Sulfamethoxazole | 6(3%) | 193(97%) | 0(0%) | 22(100%) | 0(0%) | 18(100%) | 0(0%) | 4(100%) | 1(10%) | 10(90%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| **Phenicols** | | | | | | | | | | | | | | | | |
| Chloramphénicol | 25(13%) | 174(87%) | 3(14%) | 19(86%) | 4(22%) | 14(78%) | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| **Quinolones** | | | | | | | | | | | | | | | | |
| Ciprofloxacin | 135(68%) | 64(32%) | 10(43%) | 12(57%) | - | - | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 0(0%) | 14(100%) | 0(0%) | 6(100%) |
| Levofloxacin | 123(62%) | 76(38%) | 6(29%) | 16(71%) | 6(33%) | 12(67%) | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 1(7%) | 13(93%) | 0(0%) | 6(100%) |
| Norfloxacin | 153(77%) | 46(23%) | 3(14%) | 19(86%) | 7(39%) | 11(61%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Ofloxacin | 143(72%) | 56(28%) | 12(57%) | 10(43%) | 5(28%) | 13(72%) | 0(0%) | 4(100%) | 0(0%) | 11(100%) | 0(0%) | 3(100%) | 1(7%) | 13(93%) | 0(0%) | 6(100%) |
| **Glycopeptides** | | | | | | | | | | | | | | | | |
| Vancomycine | 30(15%) | 169(85%) | 0(0%) | 22(100%) | 0(0%) | 18(100%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Teicoplanine | - | | - | - | 8(44%) | 10(56%) | - | - | - | - | - | - | - | - | - | - |
| **Cyclines** | | - | | | | | | | | | | | | | | |
| Tétracycline | 169(85%) | 30(15%) | 19(86%) | 3(14%) | 15(83%) | 3(17%) | - | - | - | - | - | - | - | - | - | - |
| Minocycline | 85(43%) | 114(57%) | 10(43%) | 12(57%) | 15(83%) | 3(17%) | - | - | - | - | - | - | - | - | - | - |
| **Polymyxins** | | | | | | | | | | | | | | | | |
| Colistin | - | - | - | - | - | - | 0(0%) | 4(100%) | 0(0%) | 11(100%) | - | - | - | - | - | - |
| **Other** | | | | | | | | | | | | | | | | |
| Rifampicin | 10(5%) | 189(95%) | 3(14%) | 19(86%) | 0(0%) | 18(100%) | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |
| Fosfomycin | 4(2%) | 194(98%) | 0(0%) | 22(100%) | - | - | - | - | - | - | - | - | - | - | - | - |
| Fusidic acid | 8(4%) | 191(96%) | 3(14%) | 19(86%) | - | - | - | - | - | - | - | - | - | - | 0(0%) | 6(100%) |

**Table 5: Phenotypes of bacterial strains researched**

| Phenotypes | *S. aureus* | *SCN* | *Steptococcus spp.* | *K. peumoniae* | *E. cloacae* | *Acinetobacter spp.* | *Alcaligenes spp.* | *Bacillus spp.* |
|---|---|---|---|---|---|---|---|---|
| | (n=199) | (n=22) | (n=18) | (n=4) | (n=11) | (n=3) | (n=14) | (n=6) |
| **PASE** | 189 (95%) | | - | - | - | - | - | - |
| **MRSA** | 68(34%) | | - | - | - | - | - | - |
| **WILD** | 4(2%) | 0(0%) | 10(55%) | 3(75%) | 8(73%) | 3(100%) | 8(57%) | 0(100%) |
| **MLSb Inductible** | 8(4%) | - | - | - | - | - | - | - |
| **BMR** | 27(14%) | 3(13%) | 0(0%) | 0(0%) | 0(0%) | 0(0%) | - | - |
| **BLSE** | - | - | - | - | - | - | - | - |
| **KTG** | 34(17%) | - | - | - | - | - | - | - |
| **VAN- R** | 30(15%) | 0(0%) | 0(0%) | - | - | - | - | - |

**PASE**: resistant to penicillin G, **MRSA** : *S. aureus* resistant to methicillin, **WILD** :bacteria sensitive to all the antibiotics, **MLSb** : résistant to macrolides, lincosamides and streptogramin b, **MRB** :multi résistant bacteria, **ESBL**: resistant to amoxicillin/clavulanic acid/ third generation cephalosporin, **KTG** : resistant to kanamycin, tobramycin and gentamycin, **VAN-R** : *Staphylococcus* resistant to vancomycin

## DISCUSSION

Skin infections are common in children (Bolognina et al., 2008; Caby et al., 2010). They most often occur following a loss of skin integrity (wound) that favor microbial growth. The emergence of bacterial resistance to common antibiotics has been reported in both developed and developing countries. It is underestimated due to the lack of adequate diagnostic tools in the health services of many African countries (Durot et al., 2017). In this study, the epidemiological and bacteriological aspects of skin lesions in pupils in the city of Bouaké (Côte d'Ivoire) were analysed. The prevalence of skin lesions was 38.43%. This result is comparable to that found in 2017 by Kourouma et al. (20.3%) in Abidjan. In Mali, several studies have also reported variable prevalences ranging from 18 to 30% (Konaré et al., 2013; Fofana et al., 2016) in children. This high prevalence could be explained by the fact that pupils constitute one of the most active and numerous social strata that are the most subject to accidents at public places , either in precarious locations, unlike Abidjan, the economic capital (Kourouma et al., 2017). Young pupils aged 5 to 10 years (76.62%) were the most affected with a M/F sex ratio of 1.65. This confirms that, outside school, boys without any other activity engaged in leisure activities, possibly sports. This male predominance had been reported in Mali by Fofana et al. (2016) who found 55.10% with a sex M/F ratio of 1.2. Hygiene measures were acceptable but almost half (44.86%) did not wash their hands before and after eating. Hand washing after defecation was observed in 41.38% of cases. The rate of use of drinking water was 71.96%. According to the data in the literature, the poor quality of bath water affects the skin barrier by unbalancing the normal flora of the skin. Thus, in case of wounds that are not properly treated and reinforced by poor hygiene, especially hand hygiene as observed could be the cause of wound superinfection (Vachée et al., 2009; Adegbedi et al., 2014; Niamba, 2007).

Several types of skin lesions were identified in this study; they were ulcerative (81.03%), pustular (13.80%) and vesicular (1.72%). Most of the lesions were due to trauma (79.40%); their evolution was acute (58.30%), subacute (29.19%) and chronic (12.51%) and was mainly accompanied by pain (55.38%). However, previous studies conducted in Donka revealed that pruritus was the most observed clinical sign in Guinea (Tounkara et al., 2012). Superficial skin lesions were the most frequent (88.92%) and the lower limbs were the site of predilection for the majority of lesions in 91.69% of cases. This could be explained by the constant exposure of the lower limbs to external, physical and climatic aggressions. This observation was made by Ye et al. in Burkina Faso (2003).

This study revealed a frequently positive culture of swabs at 85.28% with 277 bacterial strains identified. This positivity rate was higher than that obtained by Kassi et al. in Yopougon Attié (2016) and Kaloga et al. in Treichville (2016) with respectively 42.6% and 34% in Côte d'Ivoire. In Ethiopia, a recent meta-analysis study revealed 70% positive culture (Sisay et al., 2019).

The bacterial strains isolated were mainly dominated by Gram-positive Cocci with *S. aureus* (n=199) followed by Coagulase-Negative Staphylococci (n=22) and

*Streptococcusspp* (n=18).These bacteria are the primary causes of delayed healing and infection in both acute and chronic wounds (Bowler et al., 2001). They come from the normal skin flora, the environment (in the air or introduced by traumatic injury) and endogenous flora (primarily the gastrointestinal, oropharyngeal, and genitourinary mucosa) (Duerden et al., 1994). Here, the environment should be linked mainly to the flora of the school (microorganisms in dust or toilets) and also animal skin flora (touching domestic or farm animals particulary poorly treated). This predominance of *S. aureus* was similar to that reported in recent studies in Ethiopia and Chile (Silva et al., 2018, Sisay et al., 2019). In Guinea, this predominance was found by Ehounoud et al.(2018) using molecular techniques *S. aureus* thus remains a major human pathogen responsible for skin and soft tissue infections (Lagier et al., 2008; Garg, 2018). The identification of Gram-positive *Bacillus* strains has led to the identification of three *Bacillus* species, namely *Bacillus circulans* (n=4), *Bacillus megaterium* (n=1) and *Bacillus subtilis* (n=1). These species were easily identified in our study by Api 50CHB. The suitability of this biochemical method was confirmed by studies of Celandroni et al.(2000,2016) who additionally used the MALDI-TOF mass spectrometry and 16S rRNA gene sequencing methods. Although contacts with animals were frequently reported, no cases of cutaneous anthrax were identified during this study.

Concerning the antibiogram, most of the bacterial species isolated were resistant to the antibiotics tested. Indeed, strains of staphylococci showed high levels of resistance to Betalactam, especially penicillin G (95%). This rate is higher than those for *S. aureus* (91%) and CNS(76%) in Ethiopia (Mohammedaman et al., 2014). This high rate could be linked to the inactivation of penicillin by penicillinases produced by the majority (more than 90%) of hospital or community Staphylococci according to the literature (Elhamzaoui et al., 2009; Lowry, 2003; Daurel and Leclercq, 2008). Penicillin G thus remains the least active antibiotic against staphylococci, whether pathogenic or not (Boukhatem et al., 2015). Furthermore, 34% of *S. aureus* strains were resistant to methicillin. This MRSA rate is lower compared to that found in Ethiopia (49%) (Sisay et al., 2019). This could be related to the close human-to-human physical contact observed in children's communities and also during the practice of sports or physical activities (Ellis et al., 2004). In addition to methicillin, 17% of *S. aureus* strains expressed the KTG phenotype, they were also resistant to vancomycin (15%) and 14% were MRB strains. This low frequency of *S. aureus* BMR could facilitate the management of these infections. The most effective antibiotic was fosfomycin. CNS strains were resistant to tetracycline (86%) and ciprofloxacin (43%). Comparable results were reported by Mohammedaman et al. (2014). But in Chile no resistance was observed with tetracycline and ciprofloxacin by Silva et al. (2018).

All strains of *Streptococcusspp*. isolated were susceptible to streptomycin, in contrast to the study by Omoyibo et al. (2018) in Nigeria which reported high resistance (57%) to this molecule. Moreover, they reported high resistance (57, 1%) to gentamycin and high sensitivity (50 to 100%) to imipenem in Gram-negative bacteria, which was not the case in this study where 10 to 25% of Gram-negative bacteria were resistant to imipenem and 100% sensitive to gentamycin. *Bacillus spp*. were 100% resistant to penicillin G, as reported by Akinkunm et al.(2014) who achieved 100% resistance to penicillin V in surgical wounds.

## CONCLUSION

This study conducted in central Côte d'Ivoire (Bouaké) is the first to describe the bacteriological aspects of skin lesions in schools. It highlighted the socio-demographic characteristics of pupils with skin lesions of bacterial origin. The high presence of *S. aureus* could be linked to the non-respect of hygiene rules among primary school pupils in the town of Bouaké. Several bacterial species have shown high levels of resistance to certain antibiotics and these data could be used as a guide for antibiotic therapy in the management of skin lesions.

### Ethic statement

The ethic committee “Direction médicale scientifique du CHU de Bouaké” of Côte d’Ivoire (agreement number 011MSP/CHU-B/DG/DMS/ONAR/18) and the responsible of schools to Bouaké “Direction Régionale de l’Education Nationale DREN” (agreement number 1226/2018/DREN-BKE1) approved the study. Consents of a parent or legal guardian for children included were obtained.

### Funding

This study was supported by the German Research Foundation in the framework of a German-African collaboration project in infectiology (DFG project KL 2521/3-1).
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## ACKNOWLEDGEMENTS

We thank the children andparentsof children who participated in the study, the team of hospital “CHU de Bouake” for technical assistance, and teachers for collaboration.

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