An Institution-Based Assessment of Students' Hygiene Practices of Currency Notes: Evaluating Public Health Risks and Microbial diseases Transmission Pathways

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***Abstract*—Background: Studies from different regions of the world have conformed microbial contamination of banknotes in circulation. Banknotes are used by people of all walks of life, often without regard for money hygiene, thus increasing the chances of being an agent of disease transmission. The handling of banknotes by students with unhygienic hands and their exchange from person to person can significantly contribute to the transmission of infectious diseases, especially in the post COVID-19 era.**

Methods: An investigation to determine the health risk associated with handling banknotes in circulation was carried out among students in Catholic University of Cameroon CATUC Bamenda, Cameroon. Permission was obtained from the University, and each participant freely consented. one hundred and fifty banknotes of the five different denominations of CFA frs were collected randomly and analyzed microbiologically and biochemically using procedures previously used in similar studies for the presence of microbes.

Results: All the banknotes were found to be contaminated by both bacteria and fungi species. The most common bacterial contaminants were Staphylococcus spp (48%), Streptococcus spp (30%), and Bacillus spp (20%), while the most common fungal contaminants were yeast (29%), Penicillium spp (28%), Aspergillus spp (26%), and Mucor spp (17%). These results indicate that banknotes are suitable fomites capable of absorbing, harboring, and transmitting infectious microorganisms.

Conclusion: The Banknotes in circulation in the Catholic University of Cameroon are likely agent for disease transmission. Hygiene practices during or after handling currency is greatly encouraged to prevent infection.

Recommendations: flowing water, soap hand sanitizes and towels should be provided in all classes and students residential areas Further research should be conducted to explore the effectiveness of potential interventions to reduce microbial contamination on banknotes. In future, more complex study using molecular methods would be required to accomplish further investigation on the antibiotic resistance pattern, plasmid profile and pathogenicity of the isolates obtained

***Index Terms*—Banknotes, Microbial Contamination, Disease Transmission, Public Health**

I. INTRODUCTION

Prior to the introduction of money, economic exchanges were done through barter, a phenomenon where goods and services were directly exchanged. This system, while simple, was inconvenient and inefficient due to the problem of double coincidence of wants, ultimately leading to the development of money (Mankiw, 2021). Initially, coins made from precious metals were used as standardized media of

exchange, but due to their bulkiness and limitations in large transactions, paper banknotes in various denominations were introduced n(Davies, 2016). Banknotes subsequently became a widely used and durable form of currency for economic transactions worldwide.

The handling of banknotes with dirty hands and their exchange from person to person can significantly contribute to the transmission of infectious diseases, especially in the COVID-19 era. Banknotes are made from mixture of cotton and linen, and banknotes have a large surface area for microbes to reside on both sides (Podhajny 2004). The possibility that banknotes might act as vehicles for the transmission of potential pathogenic microorganisms was suggested in 1970 by (Abraham and Waterman 1972). Bacteria have been shown to be spread from person to person via contact with fomites, and since paper currency is commonly and routinely passed among individuals, bacteria could thus be spread on the surface of paper currency (Pope et al. 1406). Since communicable diseases can spread through contact with fomites, paper currency could play a role.

Banknotes, frequently exchanged in daily transactions, can act as vectors for a diverse array of pathogens, including bacteria, fungi, and viruses, thereby presenting a substantial public health concern. The routine and widespread circulation of paper currency facilitates the transfer of bacteria on its surface (Pope et al., 2002).

In a review of the durability and design of banknotes, Banknote World (2017) highlights that Central African CFA franc banknotes are crafted from cotton fibers. The recently issued banknotes are reinforced with a thin transparent polymer coating, enhancing their strength, water resistance, and longevity by mitigating rapid wear and tear. (Reifner, U. 2017).

Studies have shown that banknotes can act as fomites, capable of absorbing and transmitting microorganisms. Angelakis et al. (2014) established that banknotes can be contaminated with various bacteria, including Staphylococcus aureus and Escherichia coli, which can survive on the surface of banknotes for extended periods. In the context of COVID-19, the potential for viral transmission via contaminated surfaces has raised additional concerns.

The practice of exchanging banknotes hand-to-hand, especially in markets and other public spaces, increases the risk of disease transmission. In a typical market setting, money changes hands frequently, often without any intermediate hand hygiene measures. This lack of hygiene can facilitate the spread of pathogens among individuals. According to the World Health Organization (WHO, 2020), proper hand hygiene is crucial in preventing the transmission of the SARS-CoV-2 virus, which causes COVID-19.

Moreover, the habit of storing banknotes in direct contact with the skin which have resident microflora, such as bras, or other close-fitting clothing and in pockets, further exacerbates the risk. Mohan et al. (2017) highlighted that the warmth and moisture associated with such storage methods/sites can create an environment conducive for microbial growth, increasing the contamination levels of the banknotes. Skin is one of the habitats for microorganisms in the body, and According to a report by Prescott, et al 2005, the human surface tissue (skin) usually is constantly in contact with environmental microorganisms and become readily colonized by certain microbial species. Microorganisms on the skin can be transferred from cashiers, sales people and the general public to the currency notes that they handle.

In CATUC Bamenda, the circulation of banknotes is high, especially for small transactions like paying fees, transport fares and buying food. Physical examination of these banknotes reveals that many are greasy and crumpled. Most students, particularly males, do not use wallets or purses, instead storing money in pockets or even in bras, which exposes the banknotes to sweat and increases the risk of microbial contamination. Additionally, the handling of food and money without proper handwashing or sanitization is common on campus. According to the Food Safety Authority (FSA) of 1999, such practices can contribute to food-related public health incidents. (Alemanno, A. 2008). Banknote would likely be contaminated by droplets during coughing, sneezing, touching with previously contaminated hands or other materials and/or placement on dirty surface (Oyero and Emikpe 2007)

II. MATERIALS AND METHODS

2.1 Sample Collection: Thirty (30) samples of banknote of different denominations were collected randomly using convenient random sampling method as described in a manual of selecting sampling

techniques in research by Alvi Mohsin (2016). This was done to make sure no department was left out during sample collection.

With permission from CATUC Bamenda administration, banknotes were collected from students in every department. Standard aseptic sampling from CDC brochure of sample collection for microbiological analysis was used in which, a new sterile envelope was given to willing participants to put in the requested banknote denomination and sealed immediately (Sanders, E. R. 2012).

Procedure: khaki envelops were bought and sterilized by autoclaving in the university laboratory. The consented student drop in their money denomination directly into the envelopes held by the researcher in exchange of equivalent new bank notes. The source from where the student brought out the banknotes from was recorded and where he/she kept the new note was noted. The envelops were promptly transported to the laboratory for analysis.

2.2 Qualitative Bacterial Banknotes analysis

2.2.1Isolation of Microbes from Bank notes

Each banknote was placed in a universal bottle containing 10ml of sterile peptone water, the universal bottle was tightly sealed, and agitated for 2.0 minutes with a 5.0 minuets soak interval, after which the banknotes were carefully removed, and the peptone water was used as an inoculum on the cultured medias, 5.0mls of peptone water extract from each universal bottle was centrifuged and to be used to determine the presence of parasitic spores. This method was adopted from Sunita Singh, et al (2015).

2.2.2Inoculation and Incubation

Inoculation was done by drop plate techniques described Journal of Microbiological Methods 44(2) of April 2001. Using a sterile micropipette and micropipette tips on the surfaces of the different culture agars used. Aseptic techniques like flaming the surface of the culture media before inoculation and also using a different sterile micropipette tip for each inoculation to prevent contamination of the growth medium. The inoculated agar plates were then incubated at specific temperatures as directed by manufacturer.

2.2.3 Bacterial Load Count

Following Miles and Misra used in a similar study by Sunita Singh, et al 2015 serial dilution procedure, serial doubling dilutions were prepared from the peptone water filtrate of washed banknotes as shown thus 1:1, 1:2 and 1: 4. This was done by transferring dispensed 0.5 ml of the filtrate into 0.1ml of sterile peptone water, and then 0.5 ml transferred into the next tube using a syringe. Starting with the highest dilution 1µl of the test dilution was inoculated onto nutrient agar plates. The inoculum was dropped on three different spots on the prepared culture media plates. The media plates were incubated at 37°C, in aerobic conditions for 24 hours.

2.3 Culture Media Used

2.3.1MacConkey Agar: This selective differential media was prepared following manufacturer instructions; MacConkey agar permits only the growth of enteric gram-negative bacteria due to their ability to ferment lactose. This media contains crystal violet and bile salts which inhibits gram positive bacteria. Bank notes were washed using normal saline and the filtrate was inoculated by streaking technique on the surface of a prepared MacConkey agar media in a petri dish, the inoculated media was then incubated at 37°C for 48hours. This test was performed following standard procedures as described in Monica Cheesbrough District laboratory practice 2006.

2.3.2 Blood Agar: This is an enriched, bacteria growth medium which promotes growth of fastidious organisms like streptococci that do not grow well on nutrient agar and for determining the hemolytic capabilities of an organism, following standard procedures as described in Monica Cheesbrough District laboratory practice 2006, blood agar was prepared by adding 30ml of blood of blood and 600ml of prepared nutrient agar at 37°C.

2.4 Biochemical Testes

2.4.1 Gram Stain: The Gram staining test was performed to differentiate between Gram-positive bacteria (which possess a thick peptidoglycan cell wall) and Gram-negative bacteria (which have a thin peptidoglycan layer). Standard Gram staining procedures were followed as described by Cheesbrough (2006). Colonies isolated from blood agar culture were used for the test.

2.4.2 Motility Test: A semi-solid nutrient agar medium was prepared in a Petri dish and inoculated with filtrate obtained from washed banknotes.

Inoculation was performed by stabbing in a straight line along the diameter of the medium using a sterile inoculating loop. The inoculated medium was incubated at 37°C for 24 hours. The procedure was conducted according to standard methods described by Varghese (2014).

2.4.3 Catalase Test: The catalase test detects the presence of the enzyme catalase, which breaks down hydrogen peroxide into water and oxygen. It is primarily used to differentiate catalase-positive Gram-positive cocci such as Staphylococcus species from catalase-negative organisms such as Streptococcus and Enterococcus. The test was performed following standard procedures outlined by Cheesbrough (2006).

2.4.4 Indole Test: The indole test was used to determine the ability of an organism to split the amino acid tryptophan to produce indole, pyruvic acid, and ammonia through the action of tryptophanase. Indole production was detected using Kovac's reagent, which contains p-dimethylaminobenzaldehyde and reacts with indole to produce a pink coloration. A spot indole test was conducted following standard procedures described by Varghese (2014).

Oxidase Test: The oxidase test was used to identify bacteria that produce cytochrome c oxidase, an enzyme involved in the bacterial electron transport chain. This enzyme is typically present in aerobic organisms capable of utilizing oxygen as the terminal hydrogen receptor. The test aids in identifying organisms such as Pseudomonas spp., Helicobacter pylori, Campylobacter jejuni, Vibrio cholerae, Brucella spp., and Pasteurella spp. The procedure was carried out according to the standard methods described by Varghese (2014).

KIA Test: Kligler's Iron Agar (KIA) is a differential medium used to determine the ability of organisms to ferment glucose and lactose and to produce hydrogen sulfide. It is commonly used to differentiate lactose-fermenting members of the Enterobacteriaceae family (e.g., Escherichia coli) from non-lactose fermenters (e.g., Shigella dysenteriae). The test was performed according to the procedures outlined by Varghese (2014).

2.5 Fungal Specie Identification

The peptone water filtrate collected from washed banknotes, was diluted and 20µl of each diluent cultured in Sabouraud dextrose agar, the culture was examined after a week. Viable distinct colonies were isolated, stained with lactophenol cotton blue and viewed under x40 lens of a light microscope to identify fungal species. This method of fungal identification was performed as outlined in a description of medical fungi third edition by Sarah k et, al (2016).

2.6 Parasite Identification

Lugol's Iodine Wet Mount Examination

Following standard procedures in parasitic identification, succession, and infection pathways as described by Behrmann-Godel (2003), peptone water filtrate obtained from washed banknotes was collected and centrifuged. Using a sterile dropper, the sediment at the bottom of the centrifuge tube was aspirated, and a drop was placed on a clean glass slide. One drop of Lugol's iodine solution was added, and a coverslip was carefully placed over the preparation. The specimen was examined under the ×10 objective of a light microscope for the presence of spores, cysts, and other parasitic forms. Lugol's iodine enhances visualization of protozoan cyst nuclei and other internal structures, thereby facilitating identification (Cheesbrough, 2005).

All data obtained during the course of this research were entered and analyzed using Microsoft Excel (Microsoft Corporation, 2013).

III. RESULTS AND DISCUSSION

3.1 Macroscopic and Microscopic Observation

A total of one hundred and fifty samples evenly distributed among CFA denominations in the Central African Sub Region (CEMAC) were collected. The samples consisted of five different banknotes thirty of each: 500frs, 1000frs, 2000frs, 5000frs, and 10,000frs.

Growth was observed on both blood agar and Sabouraud dextrose agar but there was no growth on MacConkey agar, discrete colonies from the most diluted inoculated plates where counted and the average growth on each cultured plate was calculated.

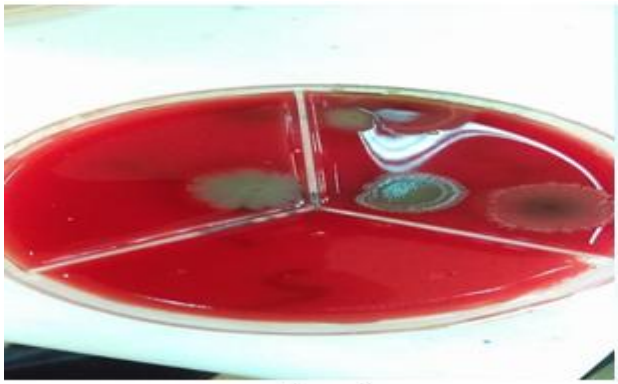

Figure 1

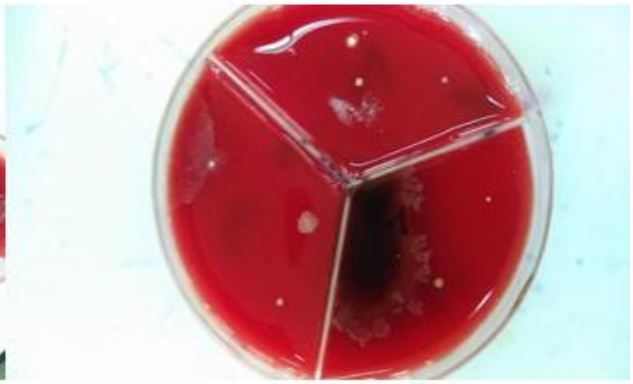

Figure 2

Figures 1 and 2 shows microbial growth on blood agar, exhibiting alpha(α) and gamma (λ)haemolysis respectively.

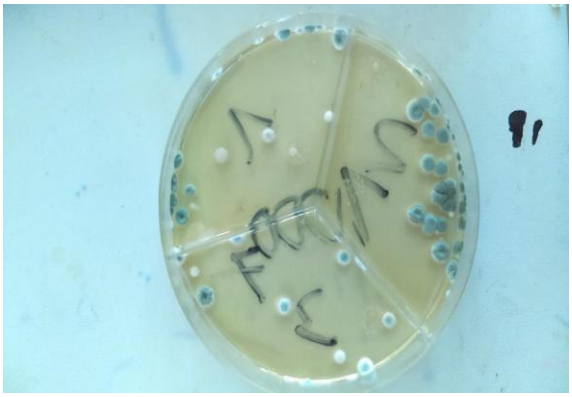

Figure 3 Figure 3 Depicts Fungal Growth on Sabouraud Dextrose Agar

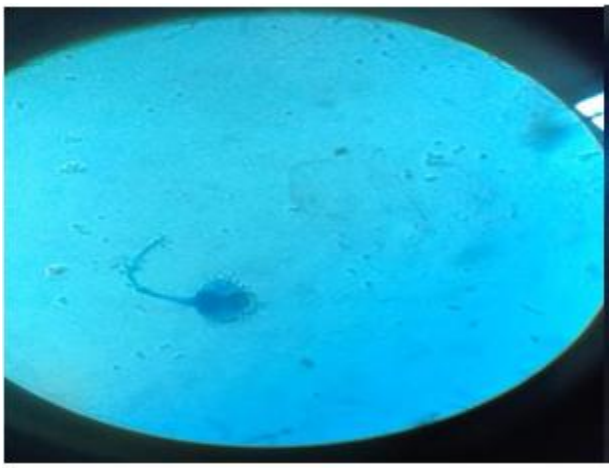

Figure 4

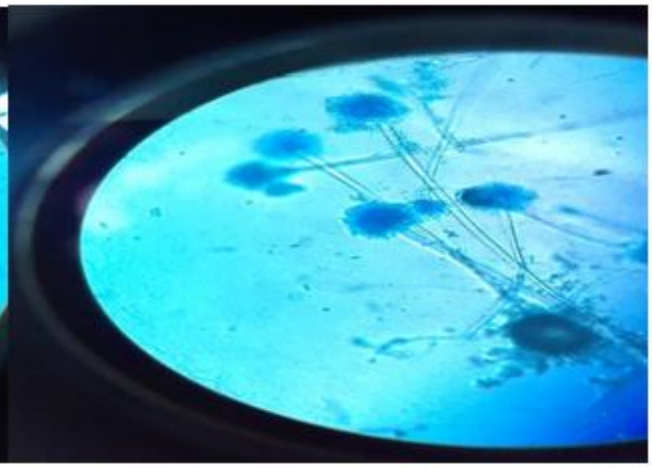

Figure 5

Figures 4 and 5, Depicts microscopic view of an Aspergillus spp and a Mucor spp respectively

Data Analysis

Results from the analysis of one hundred and fifty banknotes across various denominations (1000frs, 5000frs, 2000frs, 1000frs, and 500frs) revealed a 100% contamination rate with both bacterial and fungal species. Table 1 enumerates the specific bacterial and fungal species identified on the banknotes. Notably, a majority of these banknotes harbored multiple species of bacteria (Figure 6) and fungi (Figure 7).

Bacteria	Contamination (%)	Fungi	Contamination (%)
Staph aureus	35	Penicillium spp	28
Staph epidermidis	13	Aspergillus spp	26
Strep pneumoniae	12	Mucor spp	17
Norcadia spp	12	Yeast	29
Strep pyogenes	10		
Enterococcus spp	8		
Clostridium spp	7		
Bacilli spp	3		

Table 1. Overall percentage (%) contamination with Bacterial and fungal species

- Bacterial species contamination of the banknotes was as follows: Staphylococcus spp was the highest bacterial contaminant 48% (Staph aureus 35% and Staph epidermidis 13%) followed by Strep pneumoniae 12%, Norcadia spp 12%, Strep pyogenes 10%, Enterococcus spp 8%, Clostridium spp 7% and Bacilli spp 3%
- Fungal species contamination of banknotes was as follows: yeast (29%), penicillium spp (28%), Aspergillus spp (26%) and mucor spp (17%).

Level of Bacterial contamination based on different denominations: Table 2

Percentage Distribution Bacteria on different Banknotes					
Bacterial species	10000frs (%)	5000frs(%)	2000 frs (%)	1000frs(%)	500 frs (%)
Bacilli spp	11.11	0.00	0.00	0.00	0.00
Clostridium	3.70	18.18	0.00	11.76	6.25
Enterococcus spp	11.11	0.00	0.00	17.65	6.25
Norcadia	11.11	18.18	0.00	5.88	25.00
Staph aureus	37.04	36.36	40.00	35.29	25.00
Staph epidermidis	11.11	18.18	20.00	11.76	6.25
Strep pneumoniae	7.41	0.00	33.33	0.00	18.75
Strep pyogenes	7.41	9.09	6.67	17.65	12.50

Fungal Species	10000frs (%)	5000frs (%)	2000frs (%)	1000frs (%)	500frs (%)
Penicillium spp	40	14.29	16.67	33.33	37.50
Aspergillus spp	40	28.57	33.33	11.11	25
Mucor spp	20	42.86	0	11.11	12.50
Yeast	0	14.29	50	44.44	25

Table .3 Percentage distribution of Fungi on different Banknotes Denominations

IV. DISCUSSION

The findings of this institution-based assessment underscore the critical but often overlooked role of hygiene behavior within the WASH (Water, Sanitation, and Hygiene) framework in shaping microbial transmission risks (Manjong-Kofete, et al, 2021), associated with currency handling. WASH represents a cornerstone of public health interventions aimed at interrupting fecal–oral and contact-based transmission pathways, as classically illustrated by the F-diagram (feces, fingers, flies, fields, fluids, food). Banknotes, as frequently exchanged inanimate objects, clearly function within this transmission chain, particularly through the "fingers–food–mouth" route.

CFA franc has five denominations and we analyzed thirty banknotes from each denomination making one All the one hundred and fifty banknotes as depicted on (Table 1). were contaminated. The isolation of bacterial and fungal species from different banknote denominations examined in this study confirms that, banknotes are capable of harboring and transmitting pathogens within a university community. None of the students accepted washing of hands after touching money

The different bacteria and fungi species isolated from banknotes pose the following health risk listed in

Pathogenic Bacterial and Fungal Species	Health Risk
Staphylococcus aureus	Causes skin diseases, pneumonia and produces toxins which causes food poisoning
Staphylococcus epidermidis	Causes growth of biofilms on contaminated artificial implants, thus leading to nosocomial infections
Streptococcus spp	Causes strep throats, meningitis, bacterial pneumonia
Bacillus spp	Causes anthrax
Clostridium spp	Causes botulism
Norcadia spp	Causes opportunistic diseases in immunocompromised patients
Yeast spp	Causes candidiasis, Cryptococcosis in HIV/AIDS patients
Aspergillus spp	Produces aflatoxins which is a carcinogen and it also causes allergies and food poisoning
Penicillium spp	Causes opportunistic diseases in immunocompromised host
Mucor spp	Causes mucocutaneous and Rhinocerebral infections

Table 4: List of Bacterial and Fungal species with their Pathogenic Effects on Humans

Banknotes used in Cameroon are made out of cotton. As proposed by Vriesekoop, F. et al 2010, It is possible that the fibrous surfaces of cotton-based banknotes provide a good surface for bacterial attachment since more than one bacteria specie was often isolated from one banknote.

This study also revealed a significant increase of bacterial and fungal species on banknote denominations which have been coated with thin transparent polymer (plastic-like) materials, these plastic coating traps fungal spores and moisture, which favors growth of bacteria.

As seen in this study the lower denominations (500 Frs 1000frs and 2000frs), had the highest microbial load and, thus making them the most contaminated. Vriesekoop, F. et al (2010) suggested this was probably due to the fact that lower denominations of banknotes are often exchanged from hand to hand a lot more than higher denominations.

Staphylococcus species makes up about half of the bacterial load on each banknote analyzed, they are facultative anaerobes, and can produces the enzyme catalase, which protects them from oxidative damage, hence their ability to survive on banknote surfaces, these species can survive within temperatures ranging from 4°C to 48°C, but with an optimal growth at 37^0C, unlike strep. species that are unable to metabolize oxygen, making banknote surfaces an unsuitable habitat for them, since banknotes are frequently exposed to oxygen rich medium (air) during business transactions (especially lower denominations).

During sample collection from CATUC students, an observation on how banknotes are stored, showed that storage conditions are unhygienic and directly dirties the banknotes, giving rise to contamination and microbial growth, this confirms the findings of Igumbor (2007). From a WASH perspective, these behaviors reflect inadequate hygiene practices rather than mere lack of awareness, highlighting the behavioral dimension of hygiene that remains underemphasized in institutional health promotion programs.

The isolation of staphylococcus, streptococcus and yeast species from the bank notes indicates skin contaminants, thus affirming the report by Prescott, et al (2005).These microbes as normal flora on human skin and other body parts, under proper sanitary conditions and good health these microbes are not pathogenic, but these microbes can become pathogenic when their population on the skin and banknote surfaces exceeds normal and can be transmitted from one person to another by animate and inanimate objects as opined by Beumer, (2007). Therefore, bank notes can serve as a suitable vehicle for the transmission of these pathogens.

It was observed that so students, keep money in their socks, others tie in handkerchiefs and while most male students crumple and stuff it in their pockets these unhygienic methods of storing and carrying banknotes exposes them to further contamination.

The habit of using saliva to moisten fingers while counting money was also noticed amongst students,

these are just a few of possible methods identified by which money gets dirtied and contaminated. From a WASH lens, the habitual use of saliva to moisten fingers while counting money represents a high-risk hygiene breach, facilitating direct oral–hand–surface microbial transfer. This practice mirrors behaviors documented in low-resource settings where inadequate access to handwashing facilities or alcohol-based sanitizers perpetuates unsafe hygiene norms (WHO & UNICEF, 2023).

Notably, banknotes stored in wallets and purses exhibited comparatively lower levels of contamination, supporting evidence that improved hygiene infrastructure and behavior, even at the individual level, can significantly reduce microbial exposure. This observation resonates with recent global WASH evidence demonstrating that simple behavioral modifications—such as proper hand hygiene and safe object handling—can reduce infectious disease transmission by up to 40% (Wolf et al., 2022).

Similarly, simultaneous handling of food and money without intervening hand hygiene—observed through grease and food residues on some banknotes—aligns with earlier findings by Hadwen et al. (2000) and reinforces the role of hands as primary vectors in microbial dissemination. This study proved this true as some samples collected from students, were greased by food oils and vegetable extracts on macroscopic examination.

The absence of Gram-negative enteric bacteria and intestinal parasites in this study may be attributed to relatively improved sanitation standards and educational status within the study population. However, this finding should not be interpreted as absence of risk. Instead, it suggests that currency-associated transmission in institutional settings may be dominated by contact-based and respiratory-associated pathogens, rather than classic fecal-oral organisms. This is particularly relevant in the post-COVID-19 era, where contaminated fomites and poor hand hygiene were recognized as amplifiers of respiratory disease spread (CDC, 2020; WHO, 2021).

V. CONCLUSIONS.

This study demonstrates that banknotes circulating among students constitute a potential public health risk, acting as reservoirs and transmission vehicles for bacterial and fungal organisms of clinical and epidemiological relevance. Within the context of the CFA currency—used across six Central African countries with a combined population exceeding 55 million (World Bank, 2024)—the implications of contaminated banknotes extend beyond institutional boundaries to regional public health systems.

Despite the relatively high educational status of the study population, unsafe hygiene behaviors—including improper storage of currency, hand-to-hand exchanges without handwashing, and saliva-assisted counting—persist and significantly contribute to microbial contamination. These findings highlight a critical gap between knowledge and practice, reinforcing the need for behavior-centered WASH interventions.

The predominance of Gram-positive bacteria, alongside the absence of enteric bacteria and parasites, suggests that currency-mediated transmission in this setting is primarily driven by skin-hand-surface interactions, rather than fecal contamination. Nevertheless, such transmission pathways remain epidemiologically significant, particularly for opportunistic infections and emerging pathogens. In line with global guidance, regular handwashing with soap, use of alcohol-based hand sanitizers, and promotion of contactless payment systems are effective, low-cost strategies to mitigate these risks (CDC, 2020; WHO & UNICEF, 2023).

From a policy and research standpoint, currency hygiene should be explicitly integrated into institutional WASH programs, infection prevention and control (IPC) policies, and public health education curricula. Future studies should employ molecular and genomic techniques to characterize antimicrobial resistance profiles, plasmid carriage, and virulence determinants of currency-associated isolates, thereby strengthening surveillance of emerging public health threats.

Overall, this study situates currency hygiene as a neglected WASH interface, bridging environmental hygiene, personal behavior, and microbial ecology. It emphasizes the need to expand WASH discourse beyond water and toilets to include everyday objects that mediate microbial exchange in high-contact environments such as universities.

VI. RECOMMENDATIONS

1.Public Sensitization: Conduct frequent public awareness campaigns on hygienic methods of handling and storing banknotes in banks and financial institutions. . Specifically, discourage the practice of moistening fingers with saliva when counting money, as well as storing money in handkerchiefs, brassieres, loins, under dirty table rugs, and under food flasks.

2. Hygienic Practices for Food Handlers: Implement and enforce hygienic practices for individuals who handle both food and money. This includes washing or sterilizing hands before touching food and after handling banknotes. Mandate the use of disposable sanitary gloves for butchers, ready-to-eat food vendors, and restaurant personnel, supervised by the Food Safety and Inspection Service (FSIS).

3. Banknote Material and Handling: Replace cotton-based banknotes with polymer-based ones. Promote the use of electronic banking services such as ATMs, credit cards, and mobile money to reduce the risk of pathogen transmission.

4. Banknote Sterilization and Replacement: Develop a more efficient system for withdrawing banknotes from circulation for sterilization and replacement of torn and worn-out banknotes.

5. Proper Storage: Encourage the use of wallets to keep banknotes crisp and clean.

Disclosure; This work has not been submitted to another paper for publication

Conflicts of Interest: The authors have not declared any conflict of interests

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