

Evaluation of Parasites as Contaminants of Currency Notes in Akure, Nigeria

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Abstract

Background: Currency notes are used as a means of exchange during buying and selling of goods and commodities; thereby making them agents of disease transmission.

Objective: The aim of this study was to evaluate the rate of contamination posed on these currency notes in Akure metropolis by parasites.

Materials and Methods: A total of 160 different naira notes (5, 10, 20, 50, 100, 200, 500 and 1000) were collected from food vendors, butchers, petrol attendants and fishmongers into transparent containers and transported to the laboratory. Based on the physical appearances of the notes, they were categorized as mint, clean, dirty, very dirty and mutilated. Standard parasitological techniques were employed to detect parasitic organisms on the notes.

Results: Of the 160 naira notes examined, 106 (66.3%) harbored eggs and other stages of the parasites. Mint notes did not harbor any parasite. 14 (70%) of clean notes, 31 (62%) of dirty notes, 61 (74.4%) of very dirty and mutilated notes were contaminated, respectively. Parasites recovered from naira notes included *Enterobius vermicularis* (19.8%), Hookworm (8.5%), *Giardia lamblia* (22.6%), *Ascaris lumbricoides* (77.4%), *Hymenolepis nana* (21.7%), *Strongyloides stercoralis* (10.4%), *Trichuris trichiura* (25.5%), *Isospora belli* (2.8%), *Entamoeba histolytica* (87.7%), *Balantidium coli* (34%) and flagellates (7.5%). We found that 5, 50 and 100 naira notes had the highest contamination (45%) while 20 and 1000 naira notes had the least contamination (35% each). The results showed that there was a significant difference ($P < 0.05$).

Conclusion: Citizens should be educated on ways of handling money through personal hygiene by not abusing, mishandling or mutilating the currency notes.

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Background

In ancient times, people did not need money for successful daily transactions, they practiced trade by barter as a medium of exchange that did not involve money.^{1,2} Due to the numerous functions of currency notes such as payment of debts, buying and selling, deferred payment in economic activities, they serve as means of fuelling the spread of diseases and thereby posing a risk to public health.³ The atmosphere, mode of storage and usage, handling and production processes could serve as definite sources for note contamination.^{4,5} An individual living in unhygienic condition will, therefore, contaminate the notes and these notes act as a vehicle to contaminate the next user since they provide a large surface area as a breeding ground for pathogens.⁶

Under unhygienic condition and practices such as unwashed hand after visiting the toilet, using saliva to count paper notes, placing or storing paper notes on/in dirty surfaces lead to the impurity of the notes, therefore acting as a vehicle for delivering eggs, cysts, and oocysts of

parasites to the next user.⁷ They constitute potential public health hazard when worn-out, very dirty and mutilated paper notes are not withdrawn from circulation by the agency in charge. It has been observed that parasites of faecal origin pollute the paper notes in most situations.⁸

Currency notes with parasites have been detected in Nigeria by several scientists. Parasites that have been isolated from the currency notes in Nigeria are eggs of worms like *Ascaris lumbricoides*, Hookworms, *Trichuris trichiura*, *Enterobius vermicularis*, *Taenia*, *Toxocara*, *Hymenolepis nana* and *Hymenolepis diminuta* and cysts of protozoans like *Entamoeba histolytica*, *Giardia lamblia*, *Isospora* and *Balantidium coli*, lice and mites.^{5,9} The presence of these parasites on the naira notes poses a health risk to the masses.

Intestinal parasitic diseases are still a public health problem in developing countries, probably due to poor sanitation and inadequate personal hygiene. Intestinal parasitic infections are globally endemic and have been described as constituting the greatest single worldwide



cause of illness and diseases.¹⁰ The infection is acquired through the faecal-oral route by consumption of food, water or drinks contaminated with cysts of the parasite. Licking or sucking of faecally contaminated hands have been documented to introduce the infection to humans.¹¹ In Nigeria, intestinal parasites are prevalent and widespread.¹² There have been several reports from various parts of Nigeria which recognize them as important health problems, especially among young children. Several epidemiological studies have indicated a high prevalence of intestinal parasitic infections among Nigerian children.¹³ It was reported that the potential risks factors for human intestinal parasitic infections are *A. lumbricoides*, *T. trichiura*, *Ancylostoma duodenale*, *Necator americanus*, *B. coli*, *Giardia intestinalis* and *Blastocystis hominis* which are involved in unhygienic associations with unhygienic environments.¹⁴ *A. lumbricoides* cause ascariasis, a disease that is spread through oral contact with materials contaminated with the ova of *Ascaris*. Infection with a large number of *Ascaris* worms may cause abdominal pains or intestinal obstruction. *E. histolytica* causes amoebiasis which is spread orally through ingestion of the cyst. The pathology of the invasive form of amoebiasis is manifested with amoebic dysentery, liver abscess or possible death.¹⁵ Counting paper notes with dirty hands, saliva, storage of notes in socks, bras, under caps and carpets lead to the defilement of the notes which constitute potential a health risk. The objectives of this study are to evaluate the prevalence of parasitic organisms on Nigerian currency notes and find out which of these denominations have the highest and least contamination and what type of parasites are found on the currency notes.

Materials and Methods

Study Area

The study was carried out in Akure, Nigeria. It is located between longitude 7°15'0" N and latitude 5° 11' 42" E. The people are of Yoruba ethnic group. The study area has tropical wet and dry climate, the raining season is usually from March to October while the dry season begins in November and ends in the month of February with relative humidity between 70%-85%.

Sample Collection and Categorization

A total of 160 samples of Nigeria currency notes of all denominations (₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, ₦1000) were randomly collected from consenting individuals divided into food vendors, butchers, fishmongers and petrol stations attendants in Akure metropolis from February to May 2018. Hand gloves were worn to collect naira notes into different neat, dry and labeled containers for each denomination. The containers were transported to the undergraduate research laboratory of Biology Department, Federal University of Technology, Akure for further analysis. The

bank notes were categorized as clean, dirty and very dirty and damaged.⁶

Examination of the Naira Notes for Parasitic Contamination

After sterilizing the workbench with ethanol, the currency notes were dropped into a glass bottle containing 10 mL of normal saline according to denomination. The bottle was corked and shaken vigorously. It was allowed to settle for 30 minutes and then the notes were removed. The solution was centrifuged for 2 minutes at 500 rpm. A drop of the sediment was placed on a clean slide, 50% Lugol's stain was added and examined microscopically at X40 and X10 for the presence of parasite eggs and cysts under a microscope.

Results

Relationship Between Contamination and Physical Condition of the Naira Notes

Of 160 samples of currency notes examined for parasitic contamination, a total of 106 (66.3) were found contaminated with parasites (Table 1). We found that 5% were mint notes, 12.5% were clean notes, and 31.3% were dirty notes, while 51.3% were very dirty and mutilated. One hundred naira notes were the cleanest (20%), 1000 naira notes were the dirtier (65%) and 10 naira notes were very dirty and the most were mutilated notes (70%). Overall, 66.3% of the notes were contaminated with eggs, cysts, trophozoites and larva stage of parasites. There was no contamination in 8 of the mint notes observed, 14 (70%) of the clean notes were contaminated, 31 (62%) of the dirty notes and 61 (74.4%) of the very dirty and mutilated notes were contaminated with parasitic agents, respectively. The differences were not statistically significant ($P < 0.16$).

Prevalence of Parasitic Contamination on Naira Notes

A total of 11 parasites were isolated from the notes which included *E. vermicularis* (19.8%), Hookworm (8.5%), *G. lamblia* (22.6%), *A. lumbricoides* (77.4%), *Hymenolepis nana* (21.7%), *Strongyloides stercoralis* (10.4%), *T. trichiura* (25.5%), *Isoospora belli* (2.8%), *E. histolytica* (87.7%), *B. coli* (34%) and flagellates (7.5%). *E. histolytica* had the highest prevalence (87.7%) while *Isoospora belli* had the least prevalence of parasite (2.8%) (Table 2).

Relationship Between Prevalence of Parasite and Currency Denomination

Table 3 shows the relationship between the prevalence of parasite and currency denominations. Five naira (45%), 50 naira (45%) and 100 naira notes (45%) were the most contaminated currency notes followed by 10 Naira (40%), 200 naira (40%) and 500 naira (40%) while 20 naira and 1000 naira had the least contamination (35% each), however, there was no statistical significance ($P = 0.99$)

Table 1. Physical Condition of Currency Notes in Association with Contamination

Denomination of naira notes	Examined currency notes (n)	Mint notes No. (%)	Contaminated notes, No. (%)	Clean notes, No. (%)	Contaminated notes, No. (%)	Dirty notes, No. (%)	Contaminated notes, No. (%)	Very dirty and mutilated notes, No. (%)	Contaminated notes, No. (%)	Total contaminated notes, No. (%)
5	20	1 (5.0)	0 (0.0)	3 (15.0)	2 (66.7)	6 (30.0)	4 (66.7)	10 (50.0)	7 (70.0)	13 (65.0)
10	20	1 (5.0)	0 (0.0)	1 (5.0)	1 (100.0)	4 (20.0)	3 (75.0)	14 (70.0)	11 (78.6)	15 (75.0)
20	20	1 (5.0)	0 (0.0)	2 (10.0)	1 (50.0)	5 (25.0)	3 (60.0)	12 (60.0)	9 (75.0)	13 (65.0)
50	20	1 (5.0)	0 (0.0)	3 (15.0)	2 (66.7)	7 (35.0)	5 (71.4)	9 (45.0)	7 (77.8)	14 (70.0)
100	20	1 (5.0)	0 (0.0)	4 (20.0)	3 (75.0)	8 (40.0)	8 (100.0)	7 (35.0)	6 (85.7)	17 (85.0)
200	20	1 (5.0)	0 (0.0)	2 (10.0)	1 (50.0)	4 (20.0)	2 (50.0)	13 (65.0)	9 (69.2)	12 (60.0)
500	20	1 (5.0)	0 (0.0)	3 (15.0)	2 (66.7)	3 (15.0)	2 (66.7)	13 (65.0)	8 (61.5)	12 (60.0)
1000	20	1 (5.0)	0 (0.0)	2 (10.0)	2 (100.0)	13 (65.0)	4 (30.8)	4 (20.0)	4 (100.0)	10 (50.0)
Total	160	8 (5.0)	0 (0.0)	20 (12.5)	14 (70.0)	50 (31.3)	31 (62.0)	82 (51.3)	61 (74.4)	106 (66.3)

Table 2. Prevalence of Parasites in Relation to Currency Denomination

Denomination	Contaminated notes (n)	<i>E. vermicularis</i> (eggs, cyst, larva), No. (%)	Hookworm (eggs, cyst), No. (%)	<i>G. lamblia</i> (eggs, cyst, larva), No. (%)	<i>A. lumbricoides</i> (eggs, cyst, trophozoite), No. (%)	<i>H. nana</i> (egg, larva), No. (%)	<i>S. stercoralis</i> (eggs, cyst, larva), No. (%)	<i>T. trichiuria</i> (eggs, larva), No. (%)	<i>I. belli</i> (eggs), No. (%)	<i>E. histolytica</i> (eggs, cyst, trophozoite), No. (%)	<i>B. coli</i> (eggs), No. (%)	Flagellate, No. (%)
5	13	3 (14.2)	1 (11.1)	2 (8.3)	17 (20.7)	4 (17.4)	0 (0.0)	3 (11.1)	0 (0.0)	17 (18.3)	6 (16.7)	1 (12.5)
10	15	7 (33.3)	5 (55.6)	0 (0.0)	6 (7.3)	4 (17.4)	7 (63.6)	9 (33.3)	0 (0.0)	4 (4.3)	0	1 (12.5)
20	13	1 (4.8)	0 (0.0)	1 (4.2)	9 (10.9)	0 (0.0)	0 (0.0)	1 (3.7)	0 (0.0)	12 (12.9)	8 (22.2)	4 (50.0)
50	14	1 (4.8)	1 (11.1)	1 (4.2)	8 (9.7)	1 (4.3)	1 (9.1)	0 (0.0)	0 (0.0)	10 (10.6)	6 (16.7)	2 (25.0)
100	17	4 (19.1)	0 (0.0)	7 (29.2)	23 (28.1)	9 (39.1)	3 (27.3)	7 (25.9)	1 (33.3)	25 (26.9)	6 (16.7)	0 (0.0)
200	12	3 (14.3)	1 (11.1)	5 (20.8)	11 (13.4)	4 (17.4)	0 (0.0)	5 (18.5)	0 (0.0)	9 (9.7)	4 (11.1)	0 (0.0)
500	12	1 (4.8)	0 (0.0)	3 (12.5)	5 (6.1)	1 (4.3)	0 (0.0)	1 (3.7)	2 (66.7)	5 (5.4)	3 (8.3)	0 (0.0)
1000	10	1 (4.8)	1 (11.1)	5 (20.8)	3 (3.7)	0 (0.0)	0 (0.0)	1 (3.7)	0 (0.0)	11 (11.8)	3 (8.3)	0 (0.0)
Mint notes	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	106	21 (19.8)	9 (8.5)	24 (22.6)	82 (77.4)	23 (21.7)	11 (10.4)	27 (25.5)	3 (2.8)	93 (87.7)	36 (34)	8 (7.5)

Table 3. Prevalence of Parasites in Relation to Currency Denomination

Denomination (n)	Examined notes No. (%)	Positive No. (%)	Negative No. (%)
5	20	9 (45.0)	11 (55.0)
10	20	8 (40.0)	12 (60.0)
20	20	7 (35.0)	13 (65.0)
50	20	9 (45.0)	11 (55.0)
100	20	9 (45.0)	11 (55.0)
200	20	8 (40.0)	12 (60.0)
500	20	8 (40.0)	12 (60.0)
1000	20	7 (35.0)	13 (65.0)
Total	160	65 (40.6)	95 (59.4)

$\chi^2_{(7)} = 1.01$; $P = 0.99$

Relationship Between Parasite Contamination and the Sources of Contamination

Naira notes collected from food vendors had the highest prevalence of parasitic contamination (60%) followed by notes collected from butchers (40%). Naira notes collected from petrol attendant and fishmongers had prevalence of parasite contamination of 27.5% and 35%, respectively. This difference in the prevalence of parasite contamination with respect to the sources was statistically significant ($\chi^2 = 9.61$, $df = 3$, $P < 0.05$) (Table 4).

Discussion

The results obtained from this research work show that majority of the Naira notes in circulation within Akure metropolis are contaminated with different parasites, which is in concordance with previous reports from other parts of Nigeria.^{5,16} An overall prevalence rate of 66.3% was recorded for the currency notes examined. The presence of these parasites on the currency notes poses a health risk to the masses where necessary basic hygiene rules are not followed regimentally.

Over the last twenty years, the published data show that simultaneous handling indeed was a cause of sporadic food-borne illness and survival of pathogens on currency notes in the United States¹⁷ and China.¹⁸ In the United State of America, 13% of coins and 42% of paper money were found contaminated with potential pathogens,¹⁹ and 18% of the coins and 7% of the paper money showed potential disease producing organisms.²⁰

The paper notes are sprayed during ceremonies where they are trampled upon as they fall aground. As a result of various abusive methods such as cello taping, stapling and writing on them, these currency notes hardly last for more than one year.²¹ It was observed that ₦5, ₦50 and ₦100 notes were the most contaminated (45%) which is in consonance with a previous study.⁶ The lower denomination paper notes were statistically more contaminated than the higher denomination notes. This may be as a result of the lower denominations being

Table 4. Prevalence of Parasites in Relation to Currency Sources

Source of Currency	Examined Notes No. (%)	Positive No. (%)	Negative No. (%)
Food vendors	40	24 (60.0)	16 (40.0)
Butchers	40	16 (40.0)	24 (60.0)
Petrol attendant	40	11 (27.5)	29 (72.5)
Fishmongers	40	14 (35.0)	26 (65.0)
Total	160	65 (40.6)	95 (59.4)

used as means of exchange in day to day activities that involves buying and selling in communities where petty jobs are common such as food vendors, butchers, and fishmongers.²² The paper notes sourced from food vendors and butchers were more contaminated than notes from other sources. This could be as a result of dirty surrounding and unhygienic practices.²³

Naira notes act as a vehicle to contaminate the next user and make it possible for cross-contamination and easy transfer of parasites and pathogens.²⁴ No parasitic organism was found on fresh notes but dirty and damaged notes harbored different stages of parasitic organisms as previously reported.⁴ The presence of these parasites on the Naira notes poses a health risk to the masses in Nigeria where people do not wash their hands after counting dirty Naira notes. *Ascaris lumbricoides* and *Entamoeba histolytica* are transmitted orally. *A. lumbricoides* cause ascariasis, a disease that is spread through oral contact with objects contaminated with the ova. Infection with a large number of *Ascaris* worms may cause abdominal pains or intestinal obstruction. *Entamoeba histolytica* causes amoebiasis which is spread orally through ingestion of the cyst. The pathology of the invasive form of amoebiasis is manifested with amoebic dysentery, liver abscess or possible death.⁶

The climate, lack of good supply of potable water, illiteracy and very poor healthcare facilities are some of the factors that predispose the people to infection and diseases.^{25,26} Currency notes have been disinfected during production to limit the growth of parasitic organisms on them but, at one time or another, they serve as a vehicle for active transmission of pathogens of economic importance due to the unhygienic attitude of the users in day to day transactions.²⁷

Conclusion

The presence of parasites on Naira notes indicates that these notes can serve as a reservoir and actively transmit parasites from an infected person to a healthy individual. Non-withdrawal of dirty and mutilated notes from circulation coupled with the spraying of Naira notes during ceremonies pose a health risk to the populace. The Central Bank of Nigeria can promulgate laws on

good handling of the Naira to discourage the abuse of the notes. The practice of good personal hygiene should be encouraged and tongue-wetting of fingers during money counting should be discouraged through mass education and public awareness. Mass chemotherapy and integrated measures of parasitic control would be of utmost importance in reducing the level of infections among the populace. Therefore, it is recommended that the public should be sensitized to personal and public health; health education on these parasitic diseases should be taught in school and through the local health workers to the people of their immediate environment.

Authors' Contributions

IASO designed the study, wrote the protocol and the first draft of the manuscript. IASO and ODA managed the literature searches and performed the statistical analyses. Both authors read and approved the final manuscript.

Ethical Approval

The ethical approval was obtained from the University ethical committee before the commencement of the research.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

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