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PARASITIC CONTAMINATION OF CIRCULATING NIGERIAN CURRENCY IN ILE-IFE, OSUN STATE, NIGERIA

Akeredolu A. B.,[1,*] Salawu S.A.,[1] Balogun T. H.,[2] Adeleke A. A.[1] and Odetayo T.F[1].

[1]Department of Zoology, Obafemi Awolowo University, Ile – Ife, Nigeria.

[2]Department of Animal and Environmental Biology, Adekunle Ajasin University, Akungba Akoko.

[*]Corresponding Author's Email: dayoakeredolu@oauife.edu.ng

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ABSTRACT

This study was conducted to determine the prevalence and level of contamination of Naira notes in circulation in Ile Ife, Osun State, Nigeria. Nine hundred and sixty (960) Naira notes comprising all denominations were collected randomly from commercial bus drivers, point of sales (POS) operators, bread sellers and open market traders between October 2023 and March 2024. The parasite egg/cysts were recovered using a standard parasitological procedure. Two hundred and thirty-seven (237) Naira notes harboured one or more parasites giving an overall prevalence of 24.7%. Ten parasites were recovered which include *Ascaris lumbricoides* (14.1%) *Taenia spp* (7.8%), *Enterobius vermicularis* (5.9%), *Entamoeba histolytica* (3.4%), *Trichuris trichiura* (0.6%), *Ancylostoma duodenale* (5.0%), *Giardia lamblia* (1.3%), *Fasciola hepatica* (1.6%), *Entamoeba coli* (4.7%) and *Balantidium coli* (0.6%). The highest prevalence of contamination was recorded in N100 notes (60.0%) followed by N200 Naira notes (26.7%) while the joint lowest contamination rate of 10% was recorded in N10 Naira and N20 Naira notes respectively. Old notes were more contaminated (29.8%) than the newly redesigned notes (4.6%) and higher parasitic contamination was recorded among paper notes (27.7%) than the polymers (18%). Mutilated Naira notes were more contaminated (85.7%) than very dirty ones (50%). Based on the source of currency, Naira notes collected from commercial drivers had the highest contamination (38.8%). Statistical associations were recorded between parasitic contamination of currency and currency denomination, currency type, source of currency note, and physical condition of Naira note ($P<0.05$) except among currency materials where a non-significant association was recorded ($P>0.05$). This study has revealed that currency notes in circulation in Ile-Ife, are contaminated with a variety of parasites that pose a significant risk to public health and it is essential to promote good personal hygiene practices, such as washing hands regularly, especially after using the toilet and handling currency notes.

Keywords: Ile-Ife, Parasites, Naira notes, Contamination, Currency.

INTRODUCTION

Neglected Tropical Diseases (NTDs) are a group of long-standing diseases that disproportionately affect vulnerable populations in tropical and subtropical regions, resulting in significant human, social and economic consequences that impact over one billion people worldwide (WHO, 2021). Some of the common NTDs include Taeniasis, Chagas disease, Dracunculiasis, Fascioliasis, Leishmaniasis, Schistosomiasis, Soil transmitted helminthiasis and Onchocerciasis among others (WHO, 2021) and its widespread and persistence is fuelled by a combination of factors, including inadequate waste management, poor hygiene practices, limited awareness, cultural practices, socioeconomic inequalities and poverty (WHO, 2021).

In Nigeria, Naira notes plays a crucial role in facilitating daily economic transactions, serving as a medium of exchange for goods and services (Das, 2015; Adegoke *et al*., 2019,) and is available in various forms (coins, paper, and polymer) enabling individuals to purchase essential items and pay for services, thereby driving economic activity (Das, 2015; Attah *et al*., 2022) but the presence of parasites on currency notes in Nigeria is particularly alarming, as many individuals abuse and handle money without washing their hands, making them susceptible to a range of pathogens and parasites responsible for some of the NTDs earlier mentioned (Orababa *et al*., 2021).

Previous studies have identified Naira currency as a potential route for the transmission of pathogens responsible for various diseases (Leonard and Olajumoke, 2016; George and Ifenyinwa, 2019; Orababa *et al*., 2021; Otu-Bassey *et al*., 2021; Abdullahi *et al*., 2023; Nnachi *et al*., 2023). The risk of exposure to pathogens carried by currency notes is heightened in areas with poor personal hygiene, coughing and sneezing during

handling, usage of saliva when counting money (Orababa *et al.,* 2021), storage in unsanitary places like private parts, armpits, bra, socks and shoes or kept in containers where rodents and cockroaches can contaminate it (Hassan *et al*., 2011; Simon-Oke and Ajileye, 2019; Nnachi *et al*., 2023). In addition, usage of Naira in degrading situations like being sprayed on dance floors pose a significant threat to public health as the contaminated currency are being transferred from one hand to another. These practices create an environment that facilitates easy and steady distribution of parasitic agents, highlighting the need for improved hygiene and handling practices to mitigate this public health risk (Aminu and Yahaya, 2019).

Although few studies had been carried out on bacterial and fungal contamination on Naira note in Nigeria, the lack of awareness on the extant of the parasitic contamination of currency notes in circulation underscore this study, therefore, this current study was conducted to provide a baseline information on parasitic contamination of Nigerian currency in circulation in Ile Ife, Osun State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in Ife Central Local Government Area of Ile-Ife, Osun State, Southwest Nigeria. Ile-Ife is located on Longitude 4° 69"E and Latitude 70° 50"N with an altitude of 244m above the sea level (Sosan *et al*., 2019). The climate of the area is typically tropical with characteristics dry season of about 5 months (November-March) and wet season of about 7 months (April-October) (Salawu and Ugbele, 2015). The town has a population of 501,813 (NPC, 2006). The average annual temperature is about 30°C with an average precipitation of about 1340 mm. The inhabitants are majorly Yoruba speaking extraction of the Southwest with a few representations of people from other ethnic groups in Nigeria. The major occupation of the inhabitants is farming and trading but some are engaged in civil service, artisanship and transportation.

Sample Collection

Naira notes were collected randomly from different sources in the study area. The sources include Open market, Point of Sales (POS) operators, commercial bus drivers and bread sellers between October 2023 and March 2024. A total of 960 currency notes comprising 60 pieces each of N5, N10 and N20; 120 pieces each of N50 and N100; and 180 each of N200, N500, and N1000 denominations were also collected. The collected Naira notes were placed inside clean envelopes and transported to the Parasitology laboratory of the Department of Zoology, Obafemi Awolowo University, Ile – Ife, Nigeria.

Sample Profiling and Processing

Each currency note was profiled as follows; neat, dirty, very dirty or mutilated based on physical assessment, material (paper or polymer), denomination, source, and type of currency (whether old or newly redesigned notes for N200, N500 and N1000). Each currency note was then rolled inside a universal sample tube containing 15 ml normal saline solution and processed using the rinse method as described by Pam *et al.* (2021). The universal bottle containing the Naira notes and normal saline were vigorously shaken for few minutes and allowed to stand for 30 minutes. The Naira notes were then removed using sterilized forceps and the content of the sample bottles are transferred into centrifuge tubes and centrifuged at 1000 rpm for 5 minutes. The supernatant was decanted and the sediments were gently agitated. A drop of the sediment was placed on a clean glass slide, covered with a glass cover slip and examined under the microscope at X10 and X40 for cysts and ova of parasites.

Statistical Analysis

Data were analysed using IBM SPSS statistics 20.0 software. Prevalence based on denomination, source, physical condition of the Naira notes, and currency material was compared using Pearson's Chi-Square test. Level of significance was set at $P<0.05$.

RESULTS

Out of the 960 Naira notes that were examined, 237-Naira notes harboured one or more eggs or cysts of parasites given an overall prevalence of 24.7%.

A total of four hundred and thirty-two (432)

parasites which comprised cyst and ova of ten (10) various parasites of medical importance were recovered in this study. The recovered parasites and their prevalences are *Ascaris lumbricoides* (14.1%) *Taenia spp* (7.8%), *Enterobius vermicularis* (5.9%), *Entamoeba histolytica* (3.4%), *Trichuris trichiura* (0.6%), *Ancylostoma duodenale* (5.0%), *Giardia lamblia* (1.3%), *Fasciola hepatica* (1.6%), *Entamoeba coli* (4.7%) and *Balantidium coli* (0.6%). Ova of *A. lumbricoides* was the most abundantly recovered parasites followed by *Taenia spp* (7.8%) while cyst of *B. coli and* ova of *Trichuris trichiura* (0.6%) were the least recovered parasite as shown in Figure 1.

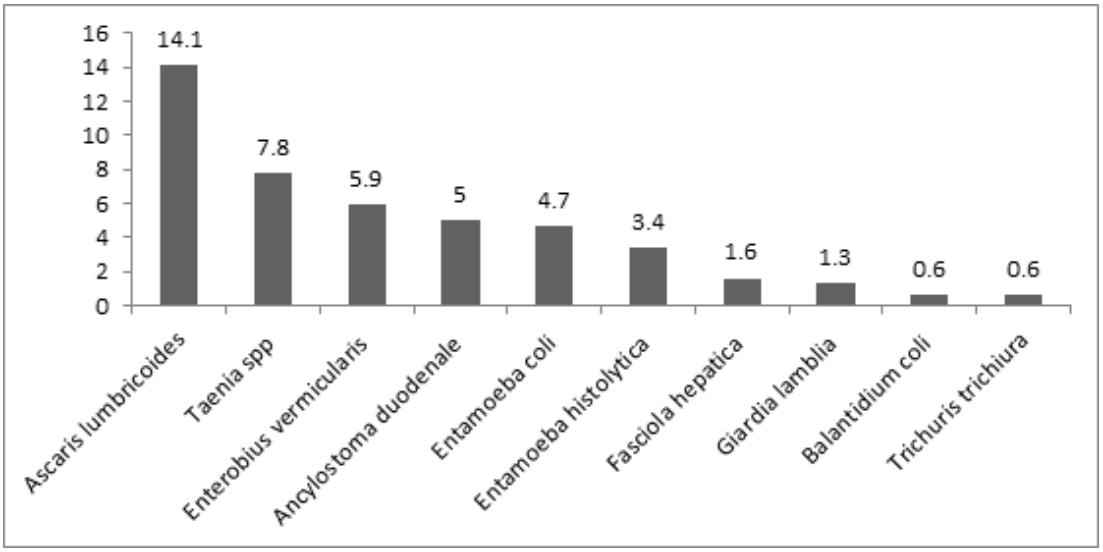

Figure 1: Recovered Parasites and their Prevalence.

All the eight denominations of Naira note that were examined in this study were reported to be contaminated with at least two or more parasites. The highest prevalence of contamination was recorded in N100 Naira notes (60.0%) followed by N200 (26.7%), N50 (25.0%), 20.0% in N5 notes, 18.3% in N 1000 notes, 16.7% in N500 notes, while joint lowest prevalence of 10.0% were recorded in both N10 and N20 (Table 1).

Table 1: Prevalence of Currency contamination in relation to currency denominations in Ile Ife.

Naira Denomination	**Number examined**	**Number of contaminated Naira notes**	**Percentage (%) Contamination**	**P value**
₦5	60	12	20.0	X^2 = 35.212, P = 0.000 Significant
₦10	60	6	10.0	
₦20	60	6	10.0	
₦50	120	30	25.0	
₦100	120	72	60.0	
₦200	180	48	26.7	
₦500	180	30	16.7	
₦1000	180	33	18.3	
Total	**960**	**237**	**24.7**	

Out of the 960 Naira notes, 765 were old currency notes and these cut across all the denominations in circulation while 195 were newly redesigned Naira notes and these were only found in N200, N500 and N1000 notes. 228 (29.8%) of the old notes were contaminated while 9(4.6%) of the newly designed notes were contaminated (Table 2). There was significant relationship [$X^2 = 17.675$, df = 1, P = 0.000] between contamination and currency type.

Table 2: Prevalence of Currency contamination in relation to currency type.

Variables	Old notes (%)	Newly redesigned Naira notes (%)	Total	P value
Contaminated	228 (29.8%)	9(4.6%)	237	$X^2 = 17.675$, P = 0.000 Significant
Not contaminated	537 (70.2%)	186 (95.4%)	723	
Total examined	**765**	**195**	**960**	

Also, 183 (27.7%) out of the 660 paper notes were contaminated with parasites while 54 (18%) of the 300 polymer notes were contaminated (Table 3). There was no significant relationship [$X^2 = 3.499$, df = 1, P = 0.061] in contamination in relation to currency material.

Table 3: Prevalence of currency contamination based on material type.

Currency material	Number examined	Number of contaminated Naira notes (%)	Percentage (%) Contamination	P value
Paper	660	183	27.7	$X^2 = 3.499$, P = 0.061 Not significant
Polymer	300	54	18.0	
Total	**960**	**237**	**24.7**	

The mutilated Naira notes had the highest contamination rate (85.7%), followed by 50% in very dirty notes, 22.1% in dirty notes, while the least was found among currencies designated as Neat (5.5%) (Table 4). The difference was statistically significant [$X^2 = 8.622$, df = 3, P = 0.001] in Naira contamination in relation to physical condition of the currency.

Table 4: Prevalence of currency contamination in relation to the physical condition of the Naira notes.

Condition of Naira notes	Total Examined	Number of contaminated Naira notes (%)	Percentage (%) Contamination	P value
Neat	273	15	5.5	$X^2 = 8.622$, P = 0.001 Significant
Dirty	516	114	22.1	
Very dirty	108	54	50	
Mutilated	63	54	85.7	
Total	**960**	**237**	**24.7**	

The Naira note with highest prevalence of contamination was recovered from commercial drivers (38.8%), followed by those from Open market (22.5%), followed by those from Point of Sale (POS) Operators (21.3%) while the least contamination of the Naira notes was recorded from those collected from Bread Sellers (16.3%). There was a significant difference [$X^2 = 12.286$, df = 3, P = 0.006] in currency contamination in relation to their source (Table 5).

Table 5: Prevalence of Naira note contamination in relation to Source of collection in Ile Ife, Osun State.

Source	Total Examined	Number of contaminated Naira notes (%)	Percentage (%) Contamination	P value
Open market	240	54	22.5	$X^2 = 12.286$, P = 0.006 Significant
POS Operator	240	51	21.3	
Driver	240	93	38.8	
Bread Seller	240	39	16.3	
Total	**960**	**237**	**24.7**	

DISCUSSION

Various studies in Nigeria (George and Ifenyinwa, 2019; Ombugadu *et al*., 2019; Simon-Oke and Ajileye, 2019; Pam *et al*., 2021; Nnachi *et al*., 2023; Gbeghebo *et al*., 2023) and in other parts of the world (Hasannezhad *et al*., 2020; Hajipour *et al*., 2020 and Hassan *et al*., 2011) have reported different rates of contamination of currency notes with ova, cysts and oocysts of various parasites. The reason for these varying prevalences might be due to differences in season of the year, local community flora, type of money (coin or banknotes), hygienic status of the population (Hajipour *et al*., 2020), the choice of parasites (bacteria, fungi, intestinal helminths), material from which the money was made (paper or polymer) (Leonard and Olajumoke, 2016), geographical location, sample size and research methodology. Also, these reports have attested to the fact that currency notes, which exchanges hands numerous times daily, serve as routes for the transmission of infective stages of parasites and pathogens that are of medical importance to humans. (Ofoedu *et al*., 2021; Abdullahi *et al*., 2023).

In this study, an overall prevalence (24.7%) of parasitic contamination was recorded among the Naira notes in Ile Ife, Osun State. This result was higher than 14.7% and 10.0% reported in Ibadan, Oyo State by Leonard and Olajumoke, (2016) and Nasarawa State by Pam *et al*., (2021). The result was similar to 26.0% reported in Bayelsa State (Gbeghebo *et al*., 2023) and 22.2% reported in Iran (Hajipour *et al*., 2020), however it was lower than 58.4%, 37.5% and 66.3% reported in Cross River (George and Ifenyinwa, (2019), Enugu State (Nnachi *et al*., 2023) and Akure, Ondo State (Simon-Oke and Ajileye, 2019) respectively.

Ten parasites of different species were isolated from Nigerian currencies obtained from the randomly selected individuals in Ile – Ife, Osun State. This corroborated the findings reported from similar studies in Nigeria (George and Ifenyinwa, 2019; Ombugadu *et al*., 2019; Simon-Oke and Ajileye, 2019; Pam *et al*., 2021; Nnachi *et al*., 2023; Gbeghebo *et al*., 2023;) and in some other parts of the world (Hassan *et al*., 2011; Hajipour *et al*., 2020 and Hasannezhad *et al*., 2020)

Handling Naira notes contaminated with ova of parasites like *Ascaris lumbricoides* puts most people at risk of contracting diseases, exacerbated by the common habit of not washing hands after handling currency. *Ascaris lumbricoides* and other recovered parasites can cause significant public health problems, including ascariasis, which spreads through oral contact with contaminated surfaces or materials, including currency notes. This parasite thrives in the intestine, feeding on partially digested food, and can lead to abdominal discomfort, stunted growth, and deficiencies in Vitamins A and C, disproportionately affecting vulnerable populations like children and pregnant women (Loung, 2002). High *Ascaris lumbricoides* contamination reported in this study was in agreement with the findings of George and

Ifenyinwa, (2019), Gbeghebo *et al*., (2023) and Nnachi *et al*., (2023) from Anambra, Bayelsa and Enugu respectively. This may be attributed to poor environmental, health and socioeconomic factors such as lack of water for proper hand washing, poverty, and ignorance about the dangers of those parasites with faeco-oral routes of transmission.

Contamination of currency was recorded in all the denominations irrespective of the material which the currency was made from (polymer or paper) however, more contamination was recovered among the paper notes than the polymer and this observation was in agreement with the findings of Ombugadu *et al*., (2019), Simon-Oke and Ajileye (2019), Pam *et al*., (2021) and Nnachi *et a*l. (2023). The reason for recovering more parasites in paper currency than polymer can be attributed to the nature of the material and texture of paper money which serves as a good attachment area, as opposed to the less receptive and smooth texture of polymer notes which prevents the adherence of parasites (Leonard and Olajumoke, 2016; Pam *et al*., 2021; Attah *et al*., 2022). On the contrary, George and Ifenyinwa, (2019) reported a higher contamination rate among the polymer notes than paper notes in their study.

This study found that the N100 denomination had the highest prevalence of parasitic contamination, which corroborates previous findings by George and Ifenyinwa (2019), Leonard and Olajumoke (2016), Uneke and Ogbu (2007), Attah *et al*. (2022), Gbeghebo *et al*., (2023) Nnachi *et al*. (2023) and Simon-Oke and Ajileye. The high contamination rate of N100 notes may be attributed to their widespread use and accessibility, particularly among low-income individuals who frequently use them for daily necessities and transportation. However, some studies have reported higher contamination rates among other denominations, suggesting that the contamination rate may vary depending on the denomination and its usage patterns.

The recent introduction of newly redesigned Naira notes has led to an interesting observation regarding the level of contamination among currency notes in circulation. Notably, the new notes have been found to have a significantly lower rate of contamination compared to the old currency notes. This disparity can be attributed to several factors, primarily the newness and scarcity of the newly introduced notes. In contrast, the old currency notes have been in circulation for over a decade, which means they have been subjected to various unhygienic conditions of handling and storage. The prolonged circulation period and extensive handling of the old notes have increased their likelihood of contamination.

The study revealed that mutilated currency notes had the highest contamination rate (85.7%), followed by very dirty notes (50%). This finding is consistent with previous research and can be justified by the fact that mutilated notes have been in circulation for a longer period, increasing their exposure to various contaminants. Additionally, the use of paper tapes and other adhesives to extend the life of mutilated notes creates additional surfaces and crevices for pathogens to attach and thrive, further contributing to their high contamination rate.

Also, this study revealed that currency notes collected from commercial drivers had the highest contamination rate (38.8%), while those collected from bread sellers had the lowest (16.3%). This finding aligns with previous research by Ombugadu *et al*. (2019) and Hajipour *et al*. (2020). The high contamination rate among commercial drivers' currency notes can be attributed to the fact that many people from diverse backgrounds and with varying levels of health and hygiene awareness rely on public transportation for their daily activities, leading to a higher risk of contamination as people from different walks of life handle the currency notes.

CONCLUSION

This study has revealed that currency notes in circulation in Ile-Ife, Osun State, Southwest Nigeria, are contaminated with a variety of parasites that pose a significant risk to public health. The contamination is widespread and indiscriminate, affecting all denominations and professions regardless of the physical condition or material of the currency.

In light of this, it is essential to promote good personal hygiene practices, such as washing hands regularly, especially after using the toilet and

handling currency notes. Additionally, habits like moistening fingers with saliva or body fluids when counting money should be discouraged.

To address this issue, the government could implement a systematic withdrawal of old and damaged notes from circulation and replace them with new, polymer-based notes. Moreover, encouraging small and medium-sized businesses and local service providers to adopt digital payment platforms can help reduce the reliance on cash and minimize the risk of parasite transmission.

Finally, individuals who handle currency notes frequently, such as bankers, drivers, traders, and commuters, should prioritize regular hand washing with soap and water to protect their health.

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CONFLICT OF INTEREST
None declared.

AUTHORS' CONTRIBUTIONS
A.A.B.: conceptualization, methodology, investigation and writing (original draft preparation). S.A.S.: methodology, validation, supervision and resources. B.T. H.: formal analysis and draft preparation. A. A. A.: formal analysis. O. T.F.: investigation. All authors read and approved the manuscript

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