Parasitic helminthes on NIGERIAN CURRENCY
A public health jeopardy

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Full Length Research

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Paper currency has been identified to be responsible for the transmission of certain pathogens. The study was conducted to determine the level of contamination of paper currency by helminth parasites within Abakaliki Metropolis. A total of 126 notes of Nigerian currency covering all the denominations at different level of physical condition were collected from people of various occupations, and analyzed using standard parasitological techniques. Out of the number 88 were test samples, while the remaining 38 which were mints from bank were control samples. None of the mints were contaminated with any parasites. The parasites recovered were Ascaris lumbricoides, Strongyloides stercoralis, Enterobius vermicularis, Trichuris trichiura, hookworm, and Dipylidium caninum. A. lumbricoides had the highest frequency of occurrence (15), whereas hookworm and D. caninum had the least. The dirty notes were more contaminated 26(45.6%) than the clean ones, (3.2%). The five hundred naira (₦500) notes had the highest contamination of 54.6% followed by the ₦100 and ₦5 notes which had 45% each. According to sources of currency, contamination was highest (50%) among notes from cobblers while vegetable farmers, food sellers, taxi drivers, brothel inmates and food stuff sellers recorded least contamination of 12.5% each. No significant statistical association was established between the parasite contamination and condition of currency, parasite contamination and denomination of currency, and parasite contamination and sources of currency. There were all insignificant (p>0.05).

Keywords: Parasites, currency, health, jeopardy

INTRODUCTION

The term “helminth” means worms and they include those that harbour the intestines and tissues. They are metazoans and are classified into platyhelminthes (cestodes and trematodes) and hemathelminths, which are the nematodes (Ichhpuja and Bhati, 2005). A parasite is an exploitative and dependent organism that lives in intimate, and in continuous association with another organism, the host (Oluburimi, 2007). Parasitic helminthes therefore, are worms that are exploitative, dependent and inhabits intimately on or in the host and in continuous association with the host. They are sometimes very pathogenic and capable of inflicting pathological injuries on the hosts.

Currency refers to the unit of exchange that facilitates the transfer of goods and services. It is a form of money, and in fact, a country’s official unit of monetary exchange. Money is an important fascinating aspect of the economy. People labour for money, fret about it and devise different ways of getting it and other means of getting rid of it. Money is a captivating, circulating, and masquerading puzzle (Podhajiny, 2004). Paper money is one of the most dirtiest objects being handled daily by individuals of various socio-economic classes. Each paper money moves from one person to another, circulating at least a dozen of times a day. If some of the notes are contaminated, there is a tendency to spread the parasites, from one individual to another (Pope et al., 2002). Currency can be seen as a fomite because it functions alike in the transmission of pathogens of public health importance.
The possibility that currency notes might act as environmental vehicles or formites for the transmission of potential microorganisms was suggested in the 1970s (Abrams and Waterman, 1972). The use of paper currency for every type of commerce is hard on the currency, with the lower-denomination notes receiving the most handling because they are exchanged frequently (Gadsby, 1998; Ogbu and Uneke, 2007). These means money which may get contaminated during production, storage, after production, and during use are always in circulation (Igumbor et al., 2007). Confirmation of contamination of money by drugs has been detected in the United States and United Kingdom (Ritter, 1997; Jenkins, 2001 and Thompson, 2002). Contamination from the skin, anal region, wounds, nasal secretions and aerosols generated by sneezing and coughing are potential sources of transfer of microorganisms to currency notes during handling (Mackintosh and Hoffman, 1984).

Recovery of parasitic helminthes from surfaces of paper currency signifies a looming damage to the public health, considering the nutritional, immunological and physiological effects of the helminthes on their human hosts. Survival of various microorganisms of concern on money is such that it could serve as a vehicle for transmission of diseases and represents an often over looked enteric reservoir (Barry, 2002).

There is a dearth of information regarding the degree to which paper money is contaminated with pathogens in general and with parasites in particular. Uneke and Ogbu (2007) reported that as at 2005, there had been no documented study on the parasitological status of currency notes. Studies on bacterial contamination abound. They include among others, the work of Gads (1998), Pope et al. (2002) and Oyero and Emikpe (2007). Up to date, there is scanty information regarding the parasitic helminth contamination of paper currency in Nigeria and elsewhere. The death of information necessitates this research so that the information gap could be bridged.

MATERIAL AND METHODS
The study area
The study was carried out in Abakaliki Metropolis in Ebonyi State, South-Eastern Nigeria. Abakaliki is the capital city of Ebonyi State, Nigeria. The climate is tropical, with two distinct seasons – rainy and dry. The former commences from April and ends in October while the later starts from November and ends in March. The average rainfall of the city is about 1500mm while the temperature range is 27-30°C. The city is located very close to the surrounding rural communities where mostly farming activities take place. Within the city, a lot of occupations by people of different socioeconomic classes take place.

Sampling techniques
A total of one hundred and twenty six (26) samples of Nigeria currency notes from twelve (12) different sources were used in the study. The sources were banks, butchers, food stuff traders, smoked-fish sellers, filling stations, taxi drivers, vegetable farmers, recharge card sellers, shoe menders, brothels and food sellers. Eighty eight (88) samples out of the total population were the test samples and the remaining thirty eight (38) samples from the banks were used as the control samples. The samples were collected from June through August, 2010, using random sampling techniques. The samples were obtained by purchasing items or paying for services, using large denomination notes, thus creating the need for a balance to be given. The collected change was placed in a sterile polythene bag and the bag was sealed, and the samples were taken to the research laboratory in the Medical Laboratory Science Department of Ebonyi State University, Abakaliki for analysis.

Physical condition of the currency
The physical conditions of the currency notes were noted. They were in various physical conditions and were categorized as mint, clean or dirty/mutilated. The term mint describes currency notes that had been recently produced and obtained from banks. The mints were included in the investigation as controls. The term "clean" describes notes that had clean appearance without any obvious damage. The dirty/mutilated notes are those that were either not clearly more than one-half of the original note or were in conditions that the value was questionable, or were damaged, soiled or held together with bits of sticky tape (Uneke and Ogbu, 2007).

Laboratory investigation
Standard parasitological analysis was conducted on the 126 notes. The procedure followed Cheesbrough (1998) and WHO (2003). Using a pair of scissors the swab (which was made of very light foam material) was cut into pieces of 2 cm x 2 cm, washed with detergent and sterilized in a dilute solution of sodium hypochlorite. The pieces of foam were then rinsed in water, air dried and rinsed in 70% alcohol. They were oven-dried and stored in a well-covered container until it was ready for use. Each piece of foam was moistened with formol-saline solution and used to swab both sides of the currency notes. The swab was placed in a capped bottle containing 10 ml of formol-saline solution and the bottle was shaken vigorously. Thereafter, inner sides of the bottle with a sterile forceps and removed. The solution was poured into a centrifuge tube and centrifuged at 2,000 g for 5 min. The supernatant was discarded and the sediment was placed on a glass slide, covered with a glass cover slip and examined microscopically for ova parasites.

Statistical analysis
Differences between proportions were analyzed using Chi squared. Statistical significance was established at 0.05.
With respect to sources of currency, parasitic contamination was most prevalence among currency notes obtained from cobbler (50.0%). This was followed by notes obtained from recharge card sellers and filling station with 37.5% each (Table 3). The least prevalence was among notes obtained from vegetable farmers, food sellers, taxi drivers, brothel inmates, and food stuff traders, which had 12.5% each. The finding disagrees with that by Uneke and Ogbu (2007) that reported the most prevalence parasite (40.0%). The fact is that the highest rate of contamination was from notes got from cobbler could be attributed to the usual attitudes of cobblers could be attributed to the usual attitudes of cobblers, after paying for services rendered. It could also be related to the fact that most cobbler use some of the foot wears they mend, especially the shoes to keep their money. Also, most people when attempting to avoid robbery by thieves keep money in their shoes when they travel. These behaviours could be responsible for that, considering the fact that most of the recovered parasites were geohelminths.

With respect to currency sources and parasite species contamination frequencies, A. lumbricoides had the highest frequency (15) and contaminated those from all sources except those from fresh fish sellers, smoked fish sellers, and from food stuff sellers (Table 4). S. stercoralis had the second position, with the frequency of 6. The occurrence of A. lumbricoides with the highest frequency has been reported earlier by other workers. They attributed this to resilience of the ova. The embryonated eggs of A. lumbricoides is known to withstand environmental extremes (Hotez et al., 2003).

### Table 1: Parasite species contamination of currency notes in relation to physical conditions.

<table>
<thead>
<tr>
<th>Parasite species</th>
<th>Physical Conditions of Currency</th>
<th>Clean Number contaminated (%)</th>
<th>Dirty Number contaminated (%)</th>
<th>Total number contaminated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ex Con</td>
<td>N=31</td>
<td>N=57</td>
<td>N=88</td>
</tr>
<tr>
<td>Ascaris lumbricoides</td>
<td></td>
<td>0 (0.0)</td>
<td>15 (26.3)</td>
<td>15 (17.1)</td>
</tr>
<tr>
<td>Strongyloides stercoralis</td>
<td></td>
<td>1 (3.2)</td>
<td>4 (7.0)</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Enterobius vermicularis</td>
<td></td>
<td>0 (0.0)</td>
<td>3 (5.3)</td>
<td>3 (3.4)</td>
</tr>
<tr>
<td>Trichuris trichiura</td>
<td></td>
<td>0 (0.0)</td>
<td>2 (3.5)</td>
<td>2 (2.3)</td>
</tr>
<tr>
<td>Hookworm</td>
<td></td>
<td>0 (0.0)</td>
<td>1 (1.8)</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td></td>
<td>0 (0.0)</td>
<td>1 (1.8)</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1 (3.2)</td>
<td>26 (45.6)</td>
<td>27 (30.7)</td>
</tr>
</tbody>
</table>

### Table 2: Parasite contamination of notes in relation to currency denomination

<table>
<thead>
<tr>
<th>Parasites by Condition of Notes</th>
<th>N1000</th>
<th>N500</th>
<th>N200</th>
<th>N100</th>
<th>N50</th>
<th>N20</th>
<th>N10</th>
<th>N5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
<td>Ex Con</td>
</tr>
<tr>
<td>Clean</td>
<td>5 (0.0)</td>
<td>2 (0.0)</td>
<td>3 (0.0)</td>
<td>5 (0.0)</td>
<td>6 (0.0)</td>
<td>5 (0.0)</td>
<td>5 (0.0)</td>
<td>5 (0.0)</td>
<td>31 (3.2)</td>
</tr>
<tr>
<td>Dirty</td>
<td>6 (16.7)</td>
<td>9 (26.7)</td>
<td>2 (5.0)</td>
<td>9 (11.2)</td>
<td>8 (10.0)</td>
<td>5 (0.0)</td>
<td>6 (16.7)</td>
<td>5 (15.7)</td>
<td>57 (20.3)</td>
</tr>
<tr>
<td>Total</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>11 (0.0)</td>
<td>88 (23.9)</td>
</tr>
</tbody>
</table>

Ex = Number Examined, Con = Number contaminated (percentage in parenthesis)

### RESULTS AND DISCUSSION

Out of the 126 samples, 38 were mints obtained from the banks and were used as controls. Eighty eight were test samples which were examined for parasitic contamination. Thirty one were clean and 57 were dirty. Twenty six (45.6%) of the dirt samples were contaminated by all the species of the helminthes parasites recovered, with A. lumbricoides having the highest frequency of 15. The clean samples had a contamination rate of 3.2% and were contaminated with only S. stercoralis (Table 1). The finding that A. lumbricoides has the highest occurrence is similar to that reported by Uneke and Ogbu (2007), who reported an 8% contamination rate for A. lumbricoides.

When parasitic contamination of currency is considered in relation to the denomination of currency notes, N500 notes had the highest contamination rate of 54.6%. This was followed by 45.5% recorded for N100 and N5 notes each (Table 2). No contamination was recorded among the ten naira notes. The report of having N500 notes as the currency with the highest prevalence of parasitic contamination does not agree with that of Uneke and Ogbu (2007), who reported highest prevalence of parasitic contamination among the N100 notes. However, a high contamination rate of 45.5% among the N5 notes agree with the report of Uneke and Ogbu (2007), who reported 27.3% among the N5 notes, as second to the highest in contamination among the currency notes. The very high contamination rate of 45.5% recorded among the N100 notes and N5 notes could be attributed to the society especially among the low income earners.
Table 3: Parasite contamination of notes in relation to currency sources

<table>
<thead>
<tr>
<th>Currency Source</th>
<th>Number Examined</th>
<th>Number Contaminated</th>
<th>% Contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butchers</td>
<td>8</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Cobbler</td>
<td>8</td>
<td>4</td>
<td>50.0</td>
</tr>
<tr>
<td>Fresh fish sellers</td>
<td>8</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Recharge card sellers</td>
<td>8</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Smoked fish sellers</td>
<td>8</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Filling station (fuel sellers)</td>
<td>8</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Vegetable farmers</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Food sellers</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Taxi drivers</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Brothel inmates</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Food stuff traders</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>88</strong></td>
<td><strong>21</strong></td>
<td><strong>23.9</strong></td>
</tr>
</tbody>
</table>

Table 4: Currency sources and parasitic contamination frequencies

<table>
<thead>
<tr>
<th>Currency Source</th>
<th>A. lumbricoides</th>
<th>S. stercoralis</th>
<th>E. vermicularis</th>
<th>T. trichiura</th>
<th>Hookworm</th>
<th>D. caninum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butcher</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cobbler</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fresh fish sellers</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recharge card sellers</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Smoked dish sellers</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Filling station</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vegetable farmers</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food sellers</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taxi drivers</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brothel</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food stuff seller</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>6</strong></td>
<td><strong>3</strong></td>
<td><strong>2</strong></td>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>

mucopolysaccharide that coats the eggs render their adhesive to a wide variety of surfaces, a feature responsible for their adhesiveness to most objects, including currency notes (Crompton, 1989).

Introduction of Automated Paying Machines (ATM) for counting money especially for bank workers (to prevent them from licking or applying saliva to the fingers when counting money), withdrawal of dirty notes for circulation, and introduction of mints and very clean ones intermittently, improvement on personal hygiene, and public health education among other good health practices are highly advocated.

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