ABSTRACT

The objective of the cross-sectional study was to determine risk factors for anaemia, to determine the impact of malaria on iron deficiency, and establish the relationship between worm infestation and iron deficiency in under-five children in Imo State of Nigeria. A total of four hundred (400) children aged 6-60 months, selected by purposive sampling method, provided blood to assess anaemia, food consumption, and body measurements. Two hundred were from urban and two hundred from rural locations. Weighed 3-day food records were used to analyse food and nutrient intake. Blood samples for determination of haemoglobin, serum ferritin, packed cell volume, vitamin C, and presence of malaria parasites were obtained by vein puncture. Stool samples were collected to determine parasitic infestations. Structured and validated questionnaire was administered to elicit information related to socio-economic status of the parents, and health status of the children. Using serum ferritin (SF) cut-off <12 mg/l (WHO, 1994), 48.8% were iron deficient, and 70.5% were anaemic (Hb <105 g/l). There were varying degrees of anaemia: 38.0% had mild anaemia, 31.8% were moderately anaemic, and 0.8% was severely anaemic (WHO/UNICEF/UNN, 2001). Some (18%) were infected by worms, hook worm affected 7.8%, Ascaris ova found in 5.8%, and Taenia 3.8%. Malaria parasites were found in 42.3% of the children. The correlation values (r=-0.197; p=0.00) showed strong correlation between malaria and anaemia, and also a strong correlation between malaria and iron deficiency (r=-0.442; p<0.001). Of the 169 (42.25%) that had malaria parasites, 74.6% were iron deficient. The most risk factor associated with anaemia in children (12 – 60 months old) was helminthic infestations which was higher in rural areas (28.5%). Malaria was higher in rural children (49.5%) than in urban (35.0%) regardless of sex.

Key words: Anaemia; iron deficiency; children, risk factors; malaria; helminthes.

Introduction

Anaemia is one of the most widespread public health problems, especially in developing countries, and has important health and welfare, social, and economic consequences. These include impaired cognitive development, reduced physical work capacity, and in severe cases increased risk of mortality (Nestle, and Davidsson, 2002). Anaemia is the best known manifestation of iron deficiency. It retards physical and cognitive development. It affects about two billion people worldwide (Black, 2003).

The under-fives are among the vulnerable groups. They have accelerated need for nutrients at this critical period, especially micro-nutrients. Micronutrient deficiencies take a greater toll on the under-fives, women of child-bearing age and the aged. The effects of these micronutrient deficiencies include growth retardation which may likely militate against their reaching their maximum potentials in life (WHO, 2001).

Iron deficiency anaemia is the only micronutrient deficiency likely to affect mental function and physical activity, health and performance of under-five children. It affects the work force, the community and the nation. In fact, it is the only micronutrient deficiency that affects cognitive development of individuals, and not reversed by subsequent iron therapy. Iron deficient under-fives will have delayed psychomotor development.
and when they reach school age, they have impaired performance on tests of language skills, motor skill and co-ordination that are equivalent to a 5-10 point deficit in IQ (Walter et al., 1983).

Malaria especially from the protozoa plasmodium falciparum causes anaemia by rupturing red blood cells and by suppressing the production of red blood cells. Helminthes such as hookworms and flukes such as schistosomes can cause blood loss, and therefore, iron loss (Latham, 1997). The nematode Trichuris Trichiura can cause anaemia when the worm burden is heavy. The Trematode schistosoma haematobium can cause significant urinary blood loss in severe infections. Schistosomiasis mansoni eggs rupture the intestinal lining, resulting in the leakage of blood and other fluids and nutrients into the lumen (Latham, 1997).

Anaemia is caused by many factors which include inadequate absorption of dietary iron, that is, poor bioavailability which is the main explanation for the higher prevalence of anaemia in developing countries of Asia and other regions except where it is caused by infections such as hookworm and malaria. Another cause is insufficient dietary intake which may be as a result of poverty and / or ignorance. Other causes include increased requirements at certain stages of the life cycle. At certain periods of life iron requirements are particularly high, and therefore less likely to be met. Iron requirements for infants are 1.0mg, adolescent girls 0.8mg; adolescent boys 0.6mg; non-pregnant women 0.6mg; preschool and school children 0.4mg; and adult men 0.3mg. Blood loss and parasites can also cause anaemia. This therefore, surveyed the prevalence of anaemia, and its relationship with worm infestation, and malaria if any.

Materials and Methods

This study was done in Imo State, Nigeria. It involved socio-economic characteristics of under-five parents, health status of under-five children, breastfeeding/weaning-dietary habits, health facilities/sanitary practices, and nutrition knowledge of parents.

Biochemical assessments were done with 2ml blood specimens which was collected to test for haemoglobin levels (Hb), haematocrit (PCV) levels, C-Reactive protein, malaria parasite, ascorbic acid level (vitamin C) and serum ferritin (SF).

Stool samples were collected to check for worm (helminthes) infestation. Food records which involved weighing of actual foods consumed by under-fives for three consecutive days, including one day weekend were taken. The samples of meals consumed were analyzed in the laboratory to find out their contents of the following nutrients, energy (kilogrammes), Protein (grammes), Fat (grammes), Carbohydrate (grammes), Iron (mg), and Ascorbic acid (mg).

The people of the area are involved in a lot of agricultural activities. Farm produce such as cassava (Manihot esculenta), yams (Discora sp) and different vegetables are produced in Imo state. Some residents/people are involved in fishing and petty trading. Livestock such as poultry, goats, sheep and cows are reared in the area, for consumption as well as for cash.

Results and Discussion

Nutrient intake of children

Table 1: Mean daily nutrient intake of the children

<table>
<thead>
<tr>
<th>Mean intake</th>
<th>Protein g/day</th>
<th>Fat g/day</th>
<th>Carbohydrate g/day</th>
<th>Iron mg/day</th>
<th>Zinc µg/day</th>
<th>Vitamin C mg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>21.4 ±9.7</td>
<td>31.2 ±38.7</td>
<td>145.9 ±38.7</td>
<td>24.99 ±9.0</td>
<td>18.5 ±10.3</td>
<td>9.66 ±10.3</td>
</tr>
<tr>
<td>Recommended intakes</td>
<td>13-19</td>
<td>ND</td>
<td>130</td>
<td>7- 10</td>
<td>3- 5</td>
<td>15 - 25</td>
</tr>
</tbody>
</table>

Table 1 shows that the mean protein (21.4g/day) and carbohydrate (145.9g/day) were higher than the recommended levels (Wardlaw et al.; 2004). The mean iron (24.99mg/day) and zinc (18.5µg/day) intakes were above the recommended daily intakes (Wardlaw, et al, 2004). However, the major sources of iron and zinc were legumes and cereals. These foods are high in iron and zinc, they have low bioavailability. This made absorption rate lower than expected because of the presence of some antinutrients (phytates and oxalates), (Lomnnerdal, 2000; Wardlaw et al, 2004.). This agrees with the result from Egypt which reported that the severe iron and zinc deficiencies were not justifiable. However, high inhibitors and low presence of enhancers in the Egyptians diet was major contributor to the problem (EDHS, 2000).

Prevalence of Iron Deficiency Anaemia in Children:

Using the cut off of serum ferritin (SF) <12.mg/l (WHO, 1994), 51.3% of the children studied had normal iron levels and 48.8% were iron deficient (Fig. 1).
A low concentration of serum ferritin (SF) <12mg/l is indicative of depleted iron stores (Hercberg et al., 1985). The overall high prevalence of anaemia in under-five children agrees with reports from Sub-Saharan Africa, East Africa and some other WHO regions (Stoltzfus et al., 2002; Tatala, 2004). It also agrees with the results of Sumarno and Komari (2004) among Indonesian children. A few, 55.5%, pre-school children had iron deficiency anaemia.

Worm Infestation in Children:

In Fig. 2, about 82% of the children tested had no form of worm infestation. Some (18%) were infected by worms. Among the worms identified, hook worm was endemic, it affected 7.8% of the children followed by Ascaris ova (5.8%) and Taenia (3.8 %.). Other helminthes identified were D. Latum (0.3%), Revi. Sci (0.3%) and infertile Ascaris ova (0.55%).

This result agrees with the results from India. Gopald (2003) reported that 22-25% of children he studied had round worms. He observed that infected children were on the average lighter (2kg), shorter (2cm) than their non-infected peers. The average Hb levels were 10.9g/l against non-infected 11.6g/l. Brooker et al (1999) reported that there was high relationship between hookworm and iron status.

Worm Infestation Based on Location:

The children in the rural communities who had hookworm, ascaris and taenia worms were 13.05%, 8.0% and 6.5%, respectively. About 71.5% had no worm infestation. In the urban areas, 92.0% of the children had no worms and 2.5%, 3.5% and 1.0% had hookworm, ascaris and taenia, respectively. When the levels of worm infestation between locations were compared the children in rural areas had significantly higher worm infestation (p< 0.01). More children from the rural areas were infected with all forms of worms (56.3%) than children in urban (43.7%).

Table 2: Association of parasitic infestation with iron deficiency.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Normal iron n=205</th>
<th>Low iron (n=195)</th>
<th>Total</th>
<th>Pearson’s Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helminthics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have helminthes</td>
<td>15(20.5%)</td>
<td>58(79.5%)</td>
<td>73(100%)</td>
<td>-0.279*(0.001)</td>
</tr>
<tr>
<td>No helminthes</td>
<td>190(58.1%)</td>
<td>137(41.9%)</td>
<td>327(100%)</td>
<td></td>
</tr>
<tr>
<td>C- Reactive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At high risk</td>
<td>22(28.9%)</td>
<td>54(71.7%)</td>
<td>76(100%)</td>
<td>-0.305*</td>
</tr>
<tr>
<td>At mild risk</td>
<td>31(35.2%)</td>
<td>57(64.8%)</td>
<td>88(100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>At no risk</td>
<td>152(64.4%)</td>
<td>84(35.62%)</td>
<td>236(100%)</td>
<td></td>
</tr>
</tbody>
</table>
The association between parasitic infection and iron deficiency anaemia is shown in Table 2. Correlation was significant at 0.01 levels (p<0.01).

Table 2 showed 79.5% of the children who had helminthes were iron deficient as against 41.9% of those without helminthes. It can be deduced that parasitic infestation significantly affected (p<0.01) the ferritin level of the children, and as such predisposed them to iron deficiency. The children who had any form of worm were more iron deficient (79.5%), than others (20.5%).

This result is in agreement with the result of others (Asinobi and Onimawo, 2007; Stoltzfus, 1997). They observed that 51% of the anaemic children were iron deficient and that if hookworm could be reduced by as much as 25% it would reduce iron deficiency anaemia by 35% and severe anaemia by 73%. This result confirmed the estimate of Malentiea (1990) that 50—80% of young children under age of five years suffer from iron deficiency. He observed that the development of anaemia was aggravated by haemorrhage due to parasites, hemolytic, caused by malaria, and abnormalities of red blood cells. Ten percent (10%) or less of anaemia and iron deficiency anaemia was attributable to malaria in Zanzibar (Stoltzfus et al., 1997).

However a similar trend was observed for the children having CRP level more than 10mg/l. They were at higher risk of developing iron deficiency. Many children who had CRP levels less than 10mg/l had normal iron stores (SF level), and more of the children who had CRP levels more than 10mg/l were iron deficient.

Level of Malaria Parasites in Children:

Among the total number of children tested for malaria parasite, 42.3% were positive and 57.8% had negative values (Table 3).

Table 3: Malaria Parasites in children.

<table>
<thead>
<tr>
<th></th>
<th>General</th>
<th>Rural</th>
<th>Urban</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>N = 400</td>
<td>n = 200</td>
<td>n = 200</td>
<td>n = 195</td>
<td>n = 207</td>
</tr>
<tr>
<td>Positive</td>
<td>169(42.3)</td>
<td>99(49.5)</td>
<td>70(35.0)</td>
<td>89(43.5)</td>
<td>85(41.1)</td>
</tr>
<tr>
<td>Negative</td>
<td>231(57.8)</td>
<td>101(50.5)</td>
<td>130(65.0)</td>
<td>109(56.5)</td>
<td>122(48.9)</td>
</tr>
</tbody>
</table>

Table 3 shows that children who had severe anaemia, 86.4% had malaria parasites as against only 13.6% of those without parasites. Fairbanks (1999) identified malaria as a very important cause of anaemia. There was strong negative correlation between anaemia and malaria parasite as shown in Table 3. This indicated that children with malaria parasite were more anaemic than those without.

Approximately more than half (50.5%) of children in rural areas had negative malaria parasite, and 35.0% had positive in the urban areas (Table 3). This result indicated that the prevalence of malaria parasite was significantly higher (p<0.001) in children in rural areas (58.6%) than those in urban areas (41.4%).

Table 4: Association between malaria and iron deficiency.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>No deficiency</th>
<th>Iron deficiency</th>
<th>Correlation with Iron deficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>126(74.6)</td>
<td>43(25.4)</td>
<td>-0.442</td>
</tr>
<tr>
<td>Negative</td>
<td>69(29.9)</td>
<td>162(70.1)</td>
<td>(&lt; 0.001)</td>
</tr>
</tbody>
</table>

This present study showed a strong correlation between malaria and iron deficiency (r = -0.442; p<0.001). Of the 169(42.25%) that had malaria parasites 25.4% were not iron deficient and 74.6% were iron deficient. Among those that had no malaria parasites, 70.1% of them were not iron deficient, 29.9% were iron deficient (Table 4). This showed that malaria has strong influence on iron deficiency.

Conclusion:

1. Iron deficiency and anaemia were the public health diseases that affected a larger proportion of under-five children in Imo State. About 70.5% of the under-fives were anaemic. The other proportion of under-fives, 48.8% was iron deficient. Anaemia was much more prevalent in rural areas (78.7%) than urban (61.3%). There was no difference in anaemia between the boys and girls in Imo State.

2. The most risk factor associated with anaemia in children (12 – 60 months old) was helminthic infections which was higher in rural areas (28.5%). Other factors were hookworm, ascaris and taenia. The latter was much lower in rural than in urban areas while the former two were higher in rural areas. Malaria was higher in rural children (49.5%) than in urban (35.0%) regardless of sex.

3. Less than 50% of the children were iron deficient (48.8%). Worm infestations, malaria parasites and elevated C-reactive protein militated against iron status of the subjects as well as locations. More children were iron deficient in rural areas (61.0%) than 45.6% in urban communities.
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