The Prevalence of Anemia and Hookworm 
*Ancylostoma Duodenale* Infection in Mishamish Village, 
Al-Hashimya District, Babylon Province, Iraq

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Abstract

This study was carried out to investigate the prevalence of anemia and its relation to hookworm *Ancylostoma duodenale* infection.

Anemia is a common health problem all over the world and Iron Deficiency Anemia IDA is the most common and important type of anemia which is causally associated with developmental delay and with poor growth. Hookworm infection is one of the important common cause of IDA.

The study included 138 subjects of different ages from Mishamish village of Al-Hashimya District, Babylon Province, Iraq. Fecal specimens and blood samples were collected from each subject.

Fecal samples were microscopically examined by direct and saturated salt floatation technique to investigate the hookworm infection.

Red Blood Corpuscles Count (RBC), Hemoglobin concentration (Hb), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), Haematocrit (Hct), Mean Corpuscular Volume (MCV), and Red cell Distribution Width (RDW) were measured by automated counter.

Overall anemia percentage was 58.7%, and was 62.7% in males compared to 53.9% in females. The highest percentage of anemia (76%) was found in children of 3-5 years age group and decreased with age progress. It was found that 37% of anemic subjects were suffering from hookworm infection.

Overall percentage of hookworm infection was 25.4%, and was 25.3% in males compared to 25.4% in females. The highest percentage of 36% was found in 3-5 years age group, and decreased as age increased.

Hookworm infection caused significant decrease (P<0.001) in mean Hb, Hct and MCV, and significant decrease (P<0.01) in MCH, but it caused significant increase (p<0.005) in RDW of hookworm infected subjects.

There was positive correlation (r = 0.94), (r = 0.97) between Hb concentration and, Hct & MCV respectively and negative correlation (r = -0.97) between RDW and Hb in hookworm infected subjects.

Hookworm infected subjects were severed from IDA especially among children and men. It should be get more attention to these groups of subjects. Treatment of anemia should be taken with the treatment of hookworm.

Keywords: anemia, hookworm, Hb, MCH, MCHM, MCV, RDW

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انتشار الإصابة بفرقر الدم والديدان الشصية

في قرية مشهش، قضاء الهاشمية، محافظة Babylon، العراق

الخلاصة

قرر الدم هو أحد الأمراض الشائعة عالمياً وبعد قرر دم نقص الحديد (IDA) أكثرها شيوعاً وسبب لاعتلال النمو لدى المصابين به. تعتبر الإصابة بالديدان الشصية هي واحدة من أهم أسباب الإصابة بقرر الدم.

أجرت هذه الدراسة للتحري عن انتشار مرض قرر الدم وعلاقته بالإصابة بالديدان الشصية *Ancylostoma duodenale*. تم تلقي الدراسة على 138 شخص باعمار مختلفة من قرية مشهش، قضاء الهاشمية، محافظة Babylon، العراق. جمعت عينات دم وبراز من كل شخص. تم عدد
Introduction

Anemia is a common health problem all over the world [1,2], and the most common and important type of anemia is Iron Deficiency Anemia (IDA) [2,3], which is causally associated with developmental delay and with poor growth [4].

Hookworm infection is the important common cause of IDA [5]. Out of a global estimate of about 1500 million of anemia cases that occurred world-wide up to 900 million were attributed to IDA due to hookworm infection [6].

In a study on the prevalence of parasitic infection in Hilla general hospital [7] estimated that 30% of the people were infected with hookworm, whereas other more recent study found that the percentages of hookworm infection were 0.1% in Arbil, 1% in Basrah, 4.1% in Baghdad and 10.1% in Babylon [8]. Further studies in Babylon Province found that the percentages of hookworm infections were 0.9% among pupils in the primary schools in Al-Hashimiya district [9] and 1.1% among pupils in the primary schools in Al-Mahaweel district, Babylon province [10].

Other studies also indicated that approximately one billion people were infected with hookworm; which are soil transmitted helminthes [11]. Hookworms are usually more abundant in rural as compared to urban communities [2,12]. This is due to the presence of optimal conditions to the third larval stage (infective stage) of the hookworm to penetrate the skin, migrate through the circulation to the lungs, pass through alveolar system up to the trachea and the pharynx, and are then swallowed into the digestive system and become adult worm in the intestine [13]. Adult worm feeds by biting into the intestinal mucosa, puncturing capillaries in the intestinal villi and pumping blood in [14].

Subjects and Methods

Subjects

The study included 138 subjects of different ages from Mishamish village of Al-Hashimiya district, Babylon Province (fig.1).

Collection of samples

Fecal and blood samples were collected from each subject. Blood samples were collected by puncturing antecuvital vein and were kept in EDTA containing tubes for further hematological tests.
Hematological tests
Red Blood Corpuscles (RBC) count, Hemoglobin concentration (Hb), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), Hematocrit (Hct), Mean Corpuscular Volume (MCV), Red cell Distribution Width (RDW) were measured by automated counter (MS9).

Anemia diagnosis
Using World Health Organization criteria [12], anemia is diagnosed when Hb concentration levels fell bellow 11 gm/100ml for individuals aged 3-5 years, 12 gm/100ml for individuals aged 6-14 years and women, 13 gm/100ml for men.

Hookworm infection
Fecal samples were microscopically examined by direct and saturated salt floatation technique to investigate hookworm infection[15].

Statistical analysis
The results were statistically analyzed by using; t-test to compare between hookworm infected and non-infected subjects, and correlation factor (r) between Hb and Hct, MCV, RDW [16].

Results
Prevalence of anemia
Details of prevalence of anemia are given in table (1). Overall anemia percentage was 58.7% which means that more than half of the community of this study, were suffering from poor health conditions. Anemia percentage in males (62.7%) was higher than in females (53.9%), this is due to the high percentage of anemia in males under 6 years (90.9%) as compared with females (64.3%) within the same age group. Prevalence of anemia within 6-14 years group was (57.9%). In males this percentage was (58.7%) compared to females (56.2%) within the 6-14 age group. The anemic male percentage was 55.6% compared to 46.2% in females within the (15or+) age group.
the higher hookworm infection among men (40%) compared to women (33.3%) as shown in table 2. Overall 37% of the anemic subjects were infected with hookworm (table 2).

Table (1): Prevalence of anemia according to sex and age

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Sex</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No.</td>
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<tr>
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<td>%</td>
<td>%</td>
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</tr>
<tr>
<td>3-5</td>
<td></td>
<td></td>
<td>11</td>
<td>10</td>
<td>90.9</td>
</tr>
<tr>
<td>6-14</td>
<td></td>
<td></td>
<td>46</td>
<td>27</td>
<td>58.7</td>
</tr>
<tr>
<td>15 or +</td>
<td></td>
<td></td>
<td>18</td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>75</td>
<td>47</td>
<td>62.7</td>
</tr>
</tbody>
</table>

Table (2): Prevalence of hookworm infection among anemic subjects

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Sex</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>%</td>
<td>%</td>
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<tr>
<td>3-5</td>
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<td></td>
<td>3</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>6-14</td>
<td></td>
<td></td>
<td>11</td>
<td>40.7</td>
<td>40.7</td>
</tr>
<tr>
<td>15 or +</td>
<td></td>
<td></td>
<td>4</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>18</td>
<td>38.3</td>
<td>38.3</td>
</tr>
</tbody>
</table>

Prevalence of hookworm
Details of prevalence of hookworm infection are given in table (3). This study showed that children of under (6) years old were with high infection percentage (36%) and males of age (6-14) years or more were also highly infected (26.1).

Table (3): Prevalence of hookworm infection according to sex and age

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Sex</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No.</td>
<td>No.</td>
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<td>%</td>
<td>%</td>
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<tr>
<td>3-5</td>
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<td>11</td>
<td>3</td>
<td>27.3</td>
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<tr>
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<td></td>
<td>46</td>
<td>12</td>
<td>26.1</td>
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<tr>
<td>15 or +</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td>75</td>
<td>19</td>
<td>25.3</td>
</tr>
</tbody>
</table>

Effect of hookworm infection on Hb and RBC criteria
Details of hookworm infection on blood criteria are given in table (4). Hookworm infection caused significant decrease (p<0.001) in hemoglobin concentration (Hb) of hookworm infected subjects as compared with non infected subjects. Hookworm infection caused decrease (p<0.01) in the mean corpuscular hemoglobin (MCH) of infected subject due to the decrease in Hb concentration and significant decrease (p<0.001) in hematocrit (Hct). Hookworm infection caused a highly significant increase...
(p<0.005) in the red cell distribution width (RDW) of hookworm infected subjects as compared with non infective subjects.

Table (4): Effect of hookworm infection on hemoglobin and red blood corpuscles criteria

<table>
<thead>
<tr>
<th>Infection</th>
<th>RBCs count (X10⁶/mm³)</th>
<th>Hb criteria</th>
<th>Hct (%)</th>
<th>RBC volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hb (gm/100ml)</td>
<td>MCH (pg)</td>
<td>MCHC (gm/100ml)</td>
</tr>
<tr>
<td>Infected subj.</td>
<td>38.4 ± 8.4</td>
<td>10.48 ± 2.35</td>
<td>22.93 ± 0.38</td>
<td>33.6 ± 0.7</td>
</tr>
<tr>
<td>Non infected subj.</td>
<td>19.4 ± 6.3</td>
<td>11.76 ± 0.15</td>
<td>24.78 ± 0.18</td>
<td>33.87 ± 0.18</td>
</tr>
<tr>
<td>t-test</td>
<td>NS</td>
<td>P&lt;0.001</td>
<td>NS</td>
<td>P&lt;0.001</td>
</tr>
</tbody>
</table>

Ns: Not significant
Values = mean ± S.E (standard error)

Relationship between Hb concentration and MCV, Hct, and RDW
There was a highly positive correlation (r=0.94, r=0.97) between Hb concentration and both of Hct and MCV respectively (fig.2,3), and a highly negative correlation (r= -0.97) between Hb concentration and RDW (fig.4) in the hookworm infected subjects.

Fig.(2): Relationship between Hb concentration and Hct.
Discussion
Prevalence of anemia
Overall anemia percentage in this study (58.7%) referred that more than half of the community were suffering from poor health conditions. This high percentage might reflect poor dieting which is mainly small amounts of vegetables and fruits which may lead to nutritional anemia [17].

Anemia percentage was higher in children. Inadequate dietary iron intake is a major factor responsible for anemia in children [18,19,20,21]. Iron deficiency (ID) is the main cause of anemia in children all around the world [22,23] due to their high physiological demands [18]. It has been found that 42.1% of anemic children were infected with hookworm...
which agrees with the study of Hopkins et al. (1997) [19].

Prevalence of anemia within 6-14 years group was higher in females than males. It was found that iron deficiency is the main cause of anemia among women during their reproductive years [18,19,23,24].

Although most references indicate that the prevalence of anemia among women is greater than in men [21,25], the results of this study show that the prevalence of anemia among men was greater than in women. This is due to the higher hookworm infection among men compared to women. Since they were working with bared foot.

Our study indicates that hookworm infection was the main cause of anemia among the community, because the adult worms feed directly on blood by puncturing blood capillaries in the intestinal villi [14], and are producing anticoagulant to facilitate feeding and exacerbate intestinal blood loss [26,27]. The daily blood loss due to hookworm infection is about 200 ml in severe infection [28] and about 0.26 ml per single worm [29]. Due to this blood loss, about 3.7 mg of iron is lost daily [14]. The intensity of anemia, however; depends upon the intensity of hookworm infection [3,30,31].

Prevalence of hookworm

Prevalence of hookworm infection was about ¼ of the community, and this percentage (25.4%) was close to the overall 25.6% of hookworm infection for the whole country [7] and the 30% of hookworm infection obtained by Deneck et al. (1954) [32] in the general hospital of Hilla city. This may be due to the similarity of ecological conditions throughout the whole country. The percentage (25.4%) obtained in this study was higher than the percentage (10.1%) obtained by Niazi et al. (1975) [8] and the percentages (0.9%), (1.1%) obtained by Al-Khafaji (1999) [9] and Al-Mamori (2000) [10] respectively in their studies of prevalence of intestinal parasites in Babylon province. These conflicting results can be attributed to the fact that rural areas only were included in this study, whereas both rural and urban areas were included in the other studies. Rural areas are known to be typical areas for the prevalence of hookworms [6].

This study showed that children of under (6) years old and males of age (6-14) years or more were with high infection. This is attributed to the fact that these children are usually bare footed and there is a direct contamination with the eggs and larvae of hookworm that penetrate the skin; the common and best way of infection [6].

Effect of hookworm infection on Hb and RBC criteria

Hookworm infection caused significant decrease in hemoglobin concentration (Hb) of hookworm infected subjects as compared with non-infected subjects. This agrees with other previous studies [9,10,19,20,23,33,34,35,36,37]. Hb concentration was decreased because of blood loss in intestine due to direct feeding of adult worm on blood [38]. Every 12 worms in the intestine of hookworm infected subject may cause Hb loss of about 1% (0.4 gm) and become anemic subject [39]. Non severe blood loss did not cause decreasing in RBC count but iron deficiency may occur since chronic bleeding is one of the main important causes of IDA [40]. MCH represents Hb concentration divided by RBC count [3]. MCH decrease can be used as an indicator of IDA [5,41]. There was no significant difference in MCHC of hookworm infected and non-infected subjects, because MCHC decrease occurs in severe IDA [42].

Hookworm infected subjects had caused significant decrease in hematocrit (Hct) which agrees with the results of parasitic epidemiology study by Al-Nahi (1998) [35]. The decrease of Hct may be due to the decreasing of MCV of hookworm infected subjects as compared with non-infected subjects [19].
Our study demonstrated that hookworm infected subject had high levels in RDW as compared with non infective subjects. RDW represents an indicator of the variance in RBC volumes [43]. Increasing of RDW due to hookworm infection is a result of iron deficiency anemia IDA. Iron deficiency is correlated with RDW increase, because iron deficiency causes a reduction in hemoglobin formation and consequently an immature erythrocytes, reticulocytes (not fully mature erythrocytes with inadequate Hb content) are released to the blood stream in order to meet the physiological demands of the body. This release of immature small erythrocytes with inadequate Hb content results in variation in RBC volumes in blood stream, i.e an increase in RDW [44].

Relationship between Hb concentration and MCV, Hct, and RDW

There was a highly positive correlation between Hb concentration and both of Hct and MCV, and negative correlation between Hb concentration and RDW in the hookworm infected subjects. That could be due to the loss of blood which will then leads to anemia, the severity of which depends upon the intensity of hookworm infection and the amount of body iron [45]. RBC and iron loss induce bone marrow to produce smaller RBCs with insufficient amounts of Hb, which leads to RDW increase [34,44].

References
haemoglobin level and eosinophils counting. M.Sc. thesis. college of science, Nainawa University: 80 pp (in Arabic)