

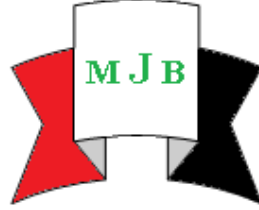
**The Prevalence of Anemia and Hookworm
Ancylostoma Duodenale Infection in Mishamish Village,
Al-Hashimya District, Babylon Province, Iraq**

Zainab H. Kamil* Karim H. Rashid** Alaa S. Al-Awad***

* College of Dentistry, Babylon University, E-mail: zainabh76@yahoo.com

** College of Science, Karbala University

*** College of Medicine, Babylon University



Received 27 May 2014

Accepted 5 August 2014

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-Hashimiya 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

انتشار الإصابة بفقر الدم والديدان الشصية *Ancylostoma duodenale*

في قرية مشيمش, قضاء الهاشمية, محافظة بابل, العراق

الخلاصة

فقر الدم هو أحد الأمراض الشائعة عالمياً ويعد فقر دم نقص الحديد (IDA) أكثرها شيوعاً ومسبب لاعتلال النمو لدى المصابين به. تعتبر الإصابة بالديدان الشصية هي واحدة من أهم أسباب الإصابة بفقر الدم.

اجريت هذه الدراسة للتحري عن انتشار مرض فقر الدم وعلاقته بالإصابة بالديدان الشصية *Ancylostoma duodenale*. شملت الدراسة على ١٣٨ شخص باعمار مختلفة من قرية مشيمش / قضاء الهاشمية / محافظة بابل / العراق. جمعت عينات دم وبراز من كل شخص. تم عد

كريات الدم الحمر RBC وتركيز الهيموكلوبين Hb ومعدل الهيموكلوبين الكريبي MCH ومعدل تركيز الهيموكلوبين الكريبي MCHC ومعدل حجم الكرية MCV ومعدل تركيز كريات الدم الحمر RDW بجهاز العد الذاتي. كانت نسبة الاصابة الكلية بقر الدم ٥٨.٧% وبلغت ٦٢.٧% في الذكور و٥٣.٩% لدى الاناث. كانت اعلى نسبة اصابة بقر الدم (٧٦%) لدى الاطفال بعمر ٣-٥ سنوات وتنخفض النسبة بتقدم . وصلت نسبة الاصابة الكلية بالديدان الشصية الى ٢٤.٤% وكانت متساوية تقريباً لدى الذكور والاناث. سببت الاصابة بالديدان الشصية انخفاضاً معنوياً ($p<0.001$) في معدل كل من تركيز Hb و Hct و MCV وانخفاضاً معنوياً ($p<0.01$) في MCH. كما سببت الاصابة زيادة معنوية ($P<0.05$) في RDW لدى الاشخاص المصابين بالديدان الشصية. بينت الدراسة وجود علاقة ارتباط موجبة ($r=0.94$) و ($r=0.97$) بين تركيز الهيموكلوبين وكل من MCH و MCV وعلاقة ارتباط سالبة ($R=-0.97$) بين تركيز Hb و RDW لدى الاشخاص المصابين بالديدان الشصية. تم تشخيص الاصابة بقر دم نقص الحديد لدى الاشخاص المصابين بالديدان الشصية خصوصاً عند الاطفال والرجال العاملين بالزراعة، لذا يجب اعطاء العلاج المناسب لقر الدم مع معالجة الاصابة بالديدان الشصية. الكلمات المفتاحية: قر الدم، الديدان الشصية، الهيموكلوبين، معدل تركيز الهيموكلوبين، حجم كريات الدم الحمر.

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-Hashimia 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 antecubital vein and were kept in EDTA containing tubes for further hematological tests



Fig. (1): Area of sample's collection

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

Age (years)	Sex						Total		
	Male			Female					
	Total	Anemic	%	Total	Anemic	%	Total	Anemic	%
	No.	No.	%	No.	No.	%	No.	No.	%
3-5	11	10	90.9	14	9	64.3	25	19	76
6-14	46	27	58.7	23	13	56.5	69	40	57.9
15 or +	18	10	55.6	26	12	46.2	44	22	50
Total	75	47	62.7	63	34	53.9	138	81	58.7

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

Age (years)	Sex				Total	
	Male		Female			
	No.	%	No.	%	No.	%
3-5	3	30	5	55.9	8	42.1
6-14	11	40.7	3	23.1	14	35
15 or +	4	40	4	33.3	8	36.4
Total	18	38.3	12	35.3	30	37

Prevalence of hookworm

Details of prevalence of hookworm infection are given in table (3). Prevalence of hookworm infection was(25.4%) about ¼ of the community.

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

Age (years)	Sex						Total		
	Male			Female					
	Total	Infected	%	Total	Infected	%	Total	Infected	%
	No.	No.	%	No.	No.	%	No.	No.	%
3-5	11	3	27.3	14	6	42.6	25	9	36
6-14	46	12	26.1	23	5	21.7	69	17	24.6
15 or +	18	4	22.2	26	5	19.2	44	9	20.5
Total	75	19	25.3	63	16	25.4	138	35	25.4

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

Infection	RBCs count (X10 ⁶ /mm ³)	Hb criteria			Hct (%)	RBC volume	
		Hb (gm/100ml)	MCH (pg)	MCHC (gm/100ml)		MCV (fl)	RDW
Infected subj.	٤.٨٣ ±٠.٠٨	١٠.٤٨ ±٠.٢٥	٢٢.٩٣ ±٠.٦٧	33.6 ±0.38	٣٢.٤٧ ±٠.٧	٦٧.٦٢ ±١.٤٤	11.56 ±٠.٢
Non infected subj.	٤.٩١ ±٠.٠٣	١١.٧٦ ±٠.١٥	٢٤.٧٨ ±٠.٣٣	33.87 ±0.18	٣٥.٨٢ ±٠.٣٨	٧٣.١٧ ±٠.٧٧	10.7 ±٠.١٣
t-test	NS	P<0.001	P<0.01	NS	P<0.001	P<0.001	P<0.005

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.

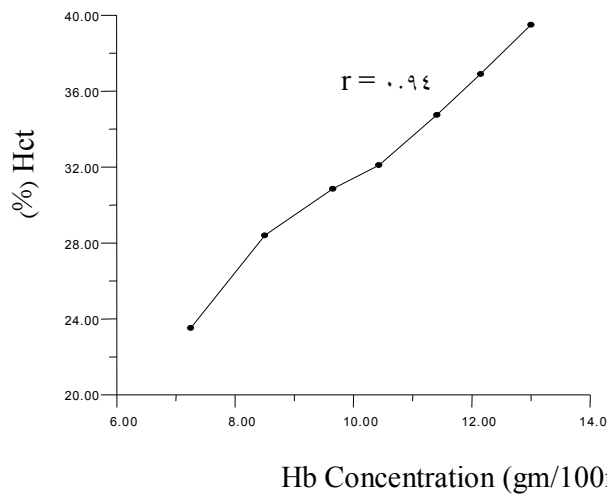


Fig.(2): Relationship between Hb concentration and Hct.

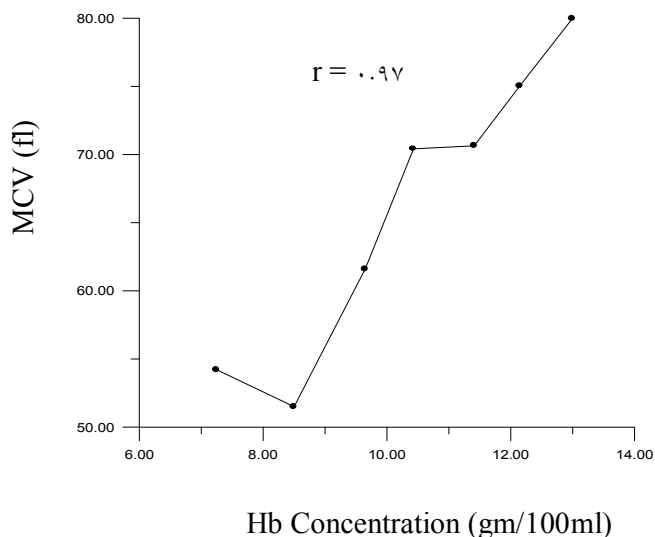


Fig.(3): Relationship between Hb concentration and MCV.

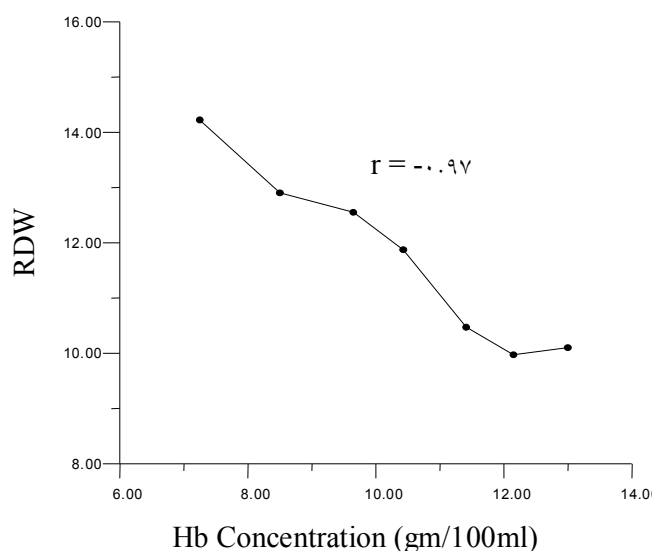


Fig.(4): Relationship between Hb concentration and RDW.

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 indicate 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

1. Palou, M.; Ocana, P.A.; Pujadas, M.A.; Gibert, M.P.; Tuduri, M.X. & Rodal, M. (2000). Anemia in primary care: etiology and morphological characteristics., *Anten-Primaria*. 25(4): 230-235
2. Shaw, J.G. & Friedman, J.F. (2011). *Iron Deficiency Anemia: Focus on Infectious Diseases in Lesser Developed Countries*, Hindawi Publishing Corporation Anemia2011:1-10.
3. Besa E.C. (1992). Introduction and principles of hematologic diagnosis.

In: Besa, E.C.; Catalano, P.M.; Jefferies, L.C. & Kant, J.A. (Eds.). *Hematology*. Harward Publ. Philadelphia

4. Booth, I.W. & Aukett, M.A. (1997). Iron deficiency anemia in infancy and early childhood. *Archives of Disease in Childhood*, 76 :549-554.

5. Frewin, R.; Henson, A. & Provan, D. (1997). *Abc of clinical hematology, Iron deficiency anemia*. B.M.J., 314: 360-363.

6. Crompton, D.W.T. (1989). Hookworm disease: current status and new directions. *Parasitology Today*, 5(1): 1-2.

7. Senekji, H.A.; Boswell, C. & Beatie, C.P. (1939). The incidence of intestinal parasites in Iraq. *Trans. Roy. Soc. Trop. Med. Hyg.*, 33 (3): 349-353.

8. Niazi, A.D.; Al-Issa, T.B; Al-Dorki, K.A.; Al-Hussaini, M.; Al-Khalissi, A. & Khamis, F. (1975). Pilot study on prevalence of Ankylostomiasis in Iraq. *Bull. End. Dis.*, 16: 105-144.

9. Al-Khafaji, A.H.A.(1999). Prevalence of intestinal parasites and lice among pupils of primary schools in Al-Hashimiya district, Babylon province. M.Sc.thesis. college of science, Babylon University:119 pp (in Arabic)

10. Al-Mamori, A.K.A.(2000). Epidemiology of intestinal parasites and lice among pupils of primary schools in Al-Mahaweel district, Babylon province. M.Sc.thesis. college of science, Babylon University:122 pp (in Arabic)

11. WHO (1998). Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. WHO/CTD/ SIP/ 98.1.

12. WHO (1995). Report of the WHO informal consultation on hookworm infection and anemia in girls and women. WHO/CDS/ IPI/ 95. 1.

13. Albonico, M. & Savioli, L. (1997). Hookworm infection and disease: advances for control. *Ann. 1st. Super. Sanita*, 33(4): 567-579

14. Crompton, D.W.T. & Whithead, R.R. (1993). Hookworm infections and

- human iron metabolism. *Parasitology*, 107: 137-145.
15. Ichhpujani, R.L. & Bhatia, R. (1994). *Medical parasitology*. Jaypee Broth. Med. Publ., New Delhi.
16. Campbell, R.C. (1967). *Statistics for biologists*. Cambridge Univ. Press.
17. Robbins, S.L.; Cotran, R.S. & Kumar, V. (1984). *Pathological basis of disease*. 3rd, edn., W.B. Saunders Company, Philadelphia.
18. Hossain, M.M.; Bakir, M.; Pugh, R.N.H.; Sheekh-Hussen, M.; BinIshaq, S.A; Berg, D.B. & Lindblad, B.S. (1995). The prevalence and correlates of anaemia among young children and women of childbearing age in Al-Ain, United Arab Emirates. *Annals of Tropical pediatrics*, 15:227-235.
19. Hopkins, R.M.; Gricey, M.S.; Hobbs, R.P.; Spargo, R.M.; Yates, M. & Thompson, R.C.A. (1997). The prevalence of hookworm infection, iron deficiency and anaemia in an aboriginal community in north-west Australia. *M.J.A.*, 166: 241-244.
20. Stoltzfus, R.J.; Chwaya, H.M.; Tielsch, J.M.; Schulze, K.J.; Albonico, M. & Savioli, L. (1997). Epidemiology of iron deficiency anemia in Zanzibari school children: The importance of hookworm. *Am. J. Clin. Nutr.*, 65: 153-159.
21. Lasthuizen, E.J.H.; Lindemans, J. & Langenhuijsen, M.M. (1998). Combined use of erythrocyte zinc protoporphyrin and mean corpuscular volume in differentiation of thalassemia from iron deficiency anemia. *Eur. J. Haematol.*, 60: 245-251.
22. Olivares, M.; Walter, T.; Hertrampf, E & Pizarro, F. (1999). Anemia and iron deficiency disease in children. 55(3): 534-543 (Abst.)
23. Kudaravalli, J.; Madhavi, S; Nagaveni, D, Deshpande, N. and Rao, M.Rama. (2011). Anemia, Iron Deficiency, Meat Consumption, and Hookworm Infection in Women of Reproductive Age in Rural area in Andhra Pradesh. *Annals of Biological Research*, 2 (3):209-216.
24. Piammongkol, S.; Chongsuvivatwong, V.; Williams, G. & Pornpatkul, M.(2006). The Prevalence And Determinants of Iron Deficiency Anemia in Rural Thai-Muslim Pregnant Women in Pattani Province., *SOUTHEAST ASIAN J TROP MED PUBLIC HEALTH*, 37 (3) May: 553-558
25. Olsson, K.S.; Marsell, R.; Ritter, B.; Olander, B.; Akerblom, A.; Ostergard, H. & Larsson, O. (1995). Iron deficiency and iron overload in Swedish male adolescents. *Journal of International Medicine*, 237: 187-194.
26. Cappello, M.; Vlasuk, G.P.; Bergum, P.W.; Huang, S. & Hotez, P.J. (1995). *Ancylostoma caninum* anticoagulant peptide: a hookworm derived inhibitor of human coagulation factor Xa. *Proc. Natl. Acad. Sci.*, 92: 6152-6156.
27. Hendrix, C.M.; Bruce, H.S.; Kellman, N.J.; Harrelson, G. & Bruhn, B.F. (1996). Cutaneous larva migrans and enteric hookworm infections. *J.A.V.M.A.*, 209 (10): 1763-1767.
28. Talib, V.H. & Khurana, S.R. (1996). *A handbook of medical laboratory technology*. 5th, edn., C.B.S. Publ., New Delhi.
29. Farid, Z.; Nichols, J.H. ; Bassily, S. & Schulert, A.R. (1985). Blood loss in pure *Ancylostoma doudenale* infection in Egyptian farmers. *Am. J. Trop. Med. Hyg.*, 14 (3): 375-378.
30. Crompton, D.W.T. (1992). Ascariasis and childhood malnutrition. *Trans. Roy. Trop. Med. Hyg.*, 86: 577-579.
31. Taverne, G. & Bradiey, J. (1998). Immunity to protozoa and worms. In: Roitt, I.; Broctoff, J. and Male, D. (Eds.). *Immunology* 5th, edn., Mosby, London.
32. Deneke, K. (1954). Diehelminthosen in Irak. *Arch. Hyg. Bakteriol.*, 138 (2): 149-156. (Helminthol. Abst.)
33. Al-Omar, N.S.N.K.(1992). Prevalence of intestinal parasites among Nainawa province and its effect on

- haemoglobin level and eosinophils counting. M.Sc.thesis. college of science, Nainawa University:80 pp (in Arabic)
34. Sanchaisuriya, P.; Saowakontha, S.; Migasena, P.; Schelp, F.P.; Pongpaew, P. & Supawan, V. (1993). Nutritional health and parasitic infection of rural Thai women of child bearing age. *J. Med. Associ. Thai.*, 76 (3): 138-145.
35. Al-Nahi, A.S.H.(1998). Epidemiology of intestinal parasites and lice among pupils of primary schools in Al-Najaf province. M.Sc.thesis. college of education, Al-Kufa University:87 pp (in Arabic)
36. Pasricha, S.; Caruana,S.R.; Phuc, T.Q.; Casey, G.J.; Jolley, D.; Kingsland, S.; Tien, N.T.; L. MacGregor,; Montresor, A. & Biggs, B.(2008). Anemia, Iron Deficiency, Meat Consumption, and Hookworm Infection in Women of Reproductive Age in Northwest Vietnam., *Am. J. Trop. Med. Hyg.*, 78(3): 375–381.
37. Sazawal, S.; Dhingra, U.; Dhingra, P.; Dutta, A.; Shabir, H.; Menon V.P. & Black, R.E.(2014). Efficiency of red cell distribution width in identification of children aged 1-3 years with iron deficiency anemia against traditional hematological markers. *BMC Pediatrics* 14:8
38. Faust, E.G.; Beaver, P.C. & Jung, R.C.(1975). Animal agents and vectors of human disease. 4th, edn., Lea & Febiger, Philadelphia.
39. Nnochiri, E. (1975). Medical parasitology in the tropics. Oxford Univ. Press., London.
40. Dagg, J. & Lee, F.D. (1982). The blood and bone marrow. In Anderson, J.R. (ed.) *Muir's textbook of Pathology* 7th, edn., Edward Arnold Publ., London.
41. Gupta, A.D.; Hegde, C. & Mistri, R. (1994). Red cell distribution width as a measure of severity of iron deficiency in iron deficiency anaemia. *Indian. J. Med. Res.*, 100: 177-183.
42. Edwards C.R.W., Bouchier, I.A. D.; Haslett, C. & Chilvers, E.R. (1996). Principles and practice of medicine. 7th, edn. Churchill, Livingstone.
43. Choi, Y.S. & Reid, T. (1998). Anemia and red cell distribution width at the 12-month well-baby examination. *Southern Medical Journal*, 19 (4): 372-374.
44. Cesana, B.M.; Maiolo, A.T.; Gidiuli, R.; Damilano, I; Massaro, P. & Polli, E.E. (1991). Relevance of red cell distribution width (RDW) in the differential diagnosis of microcytic anaemias. *Clin. Lab. Haemat.*, 13:141-151.
45. Navitsky, R.C.; Dreyfuss, M.L.; Shrestha, J.; Khatry, S. K.; Stoltzfus, R.J. & Albonico (1998). *Ancylostoma doudenale* is responsible for hookworm infections among pregnant women in the rural plains of Nepal. *J. parasitol.*, 84(3): 647-651.