

Prevalence and risk factors of anaemia in paediatric patients in South-East Nigeria

M D Ughasoro, MBBS, MPh, MSc (Health Economics), FWACP; I J Emodi, MBBS, FMCPaed; H U Okafor, MBBS, FWACP, FMCPaed; B C Ibe, MBBS, FWACP, FMCPaed

Department of Paediatrics, College of Medical Sciences, University of Nigeria, Enugu, Nigeria

Corresponding author: M D Ughasoro (kakatitis@yahoo.co.uk)

Background. The causes of anaemia have regional variations, and further variation is expected among paediatric hospital patients. However, the prevalence of anaemia and its contributing risk factors among paediatric patients remain understudied in South-East Nigeria.

Methods. The study involved 286 anaemic (haemoglobin (Hb) ≤ 10 g/dL) and 295 non-anaemic preschool children attending a hospital outpatient department. A clinical research form was used to document demographic data, anthropometric measurements, disease details and packed cell volume. Common anaemia risk factors previously documented were studied. The prevalence rates of the independent variables were calculated and level of significance was determined, using χ^2 .

Results. The prevalence of anaemia was 49.2%, with the highest prevalence among children <12 months old ($p=0.009$). There was a significant association between anaemia and maternal education above primary education ($p=0.01$), but there was no association with socioeconomic status ($p=0.7$) or nutritional status ($p=0.1$). The prevalence of the major risk factors among anaemic children was: malaria parasitaemia 48.3% ($p=0.03$), iron deficiency 42.3% ($p=0.001$), glucose-6 phosphate dehydrogenase (G6PD) deficiency 24.8% ($p=0.02$), HIV seropositivity 13.3% ($p=0.02$), sickle cell anaemia 2.4% ($p=0.3$) and helminth infection 1.1% ($p=0.32$).

Conclusions. Malaria and iron deficiency remain common among ill children <5 years old who are anaemic. The treatment of these conditions should be considered when managing an anaemic ill child in order to reduce morbidity and mortality.

S Afr J CH 2015;9(1):14-17. DOI:10.7196/SAJCH.760



Anaemia is a global health problem^[1,2] with a major debilitating effect,^[3] especially in children in sub-Saharan Africa.^[4,5] Globally, different causative factors of anaemia have been identified,^[6,7] each with an intrinsic potential to cause anaemia,^[8,9] and the relative contribution of these individual risk factors has regional variations. Even within a region, further variation between community and hospitalised children may exist.

Studies have shown that malaria,^[10-12] HIV,^[13,14] iron deficiency,^[15,16] glucose-6 phosphate dehydrogenase (G6PD) deficiency, sickle cell anaemia (SCA)^[10,11] and intestinal helminths^[17] are potential causes of anaemia. Over the years in Nigeria, different intervention programmes have been adopted based on common causes of anaemia, with the aim of preventing and controlling childhood anaemia.^[18,19] In spite of these interventions, the prevalence of anaemia remains high. Therefore, there may be some benefits if the main contributors to anaemia among ill children are determined. In addition, evaluation at the micro or small-unit level rather than national or global level will help in the design of a cost-effective intervention that can reduce anaemia-related morbidity and mortality in that locality.

Anaemia among ill children, especially those <5 years old, is associated with higher morbidity and mortality than in apparently healthy children. Our objective was to determine the prevalence of anaemia and causative factors among <5-year-old paediatric patients in South-East Nigeria. The outcome of this study will facilitate the design of an effective management protocol for anaemic children <5 years of age who present to health facilities in South-East Nigeria.

Methods

Study site and population

This study was conducted in the children's outpatient clinic (CHOP) and children's emergency room (CHER) of the University of Nigeria Teaching Hospital (UNTH) in Enugu, Nigeria. UNTH is a three-tier

health facility that receives patients from both urban and rural areas. It is strategically located in the semitropical rainforest of Nigeria with an estimated annual rainfall of more than 1 520 mm and a temperature that varies between 22.4° and 30.8°C.^[20] The malaria transmission rate is high all year round, with an average rate of more than 15% in both wet and dry seasons.

Study design

The study was a cross-sectional, hospital-based, descriptive study. All children aged between 6 and 59 months who visited the CHOP or CHER were consecutively recruited over a period of 12 months between February 2009 and January 2010. The sample size was calculated at 283 patients with Epi-Info software version 6.04 (Centers for Disease Control and Prevention (CDC), USA), using the prevalence of anaemia among children aged 6 - 59 months of 21.7%,^[5] with a 95% confidence limit.

Ethical considerations

The UNTH ethical committee gave ethical approval before the study was commenced. Written informed consent was obtained from the parents/caregivers of participating children. The results of the investigations were acted upon according to local protocol; children with anaemia diagnosed by immediate haemoglobin estimation were referred to appropriate units, where they were reviewed, investigated and managed with haematinics and/or blood transfusion as appropriate.

Data collection

A clinical research form (CRF), including a questionnaire, was administered by face-to-face interview with the respondents. The CRF was pilot-tested in a health centre in Enugu, after which certain revisions were made prior to the study. The information collected was on socioeconomic data, physical examination and anthropometric

measurements. Blood and stool samples were also collected.

Socioeconomic status

Socioeconomic status (SES) was determined according to parental educational level, and occupation according to Oyedeji.^[21] Social classes I and II were categorised as higher social classes, and III - V as lower classes.

Anthropometric measurements

Weight was measured using a Seca floor scale (Seca Corporation, USA) for children ≤24 months, and a Harson weighing scale (Harson Scales Company, USA) for children >24 months old. Recumbent length was measured using a SECA 416 measuring board for children <2 years old, while height was measured using a stadiometer for those aged ≥2 years. Each measurement was repeated to get the mean. Those children whose weight-for-age, height-for-age, and weight-for-height were below the 3rd centile of the World Health Organization (WHO) Child Growth Standard Chart were classified as underweight, stunted and wasted, respectively, while those above the 3rd centile but less than the 97th centile were classified as having normal nutrition. Children above the 97th centile for weight-for-height were classified as overweight/obese.

Haematological investigations

Haemoglobin concentration was determined using the Hemocue method (HemoCue HB 301).^[22] The WHO and CDC proposed cut-off for anaemia in

children aged 6 months - 5 years was used to categorise the children. Children with haemoglobin (Hb) ≤10 g/dL were classified as anaemic.

Blood smears for thick blood film were stained with Giemsa stain for malaria parasitaemia. The slides were viewed for the presence or absence of asexual *Plasmodium falciparum* parasites by a trained microscopist.

Total iron-binding capacity and serum iron were determined by standard direct total iron-binding capacity (TIBC) assay^[23] and the ferrozine colorimetric method, respectively.^[24] A serum iron level of <9 μmol/L and total iron-binding capacity of >80 μmol/L were taken as cut-off points for iron deficiency.

The patients' HIV status was determined using the Determine HIV 1/2 (Abbott Diagnostic Division, The Netherlands) rapid kits. G6PD status was determined using the standard methaemoglobin reduction test.^[25] Haemoglobin genotype was determined by electrophoresis of the patient's blood on cellulose acetate membrane at the alkaline pH of 8.9.^[26]

Stool study

The stool sample was examined for parasite ova using the Kato-Katz method. Presence or absence of hookworm ova was defined as infection or non-infection, respectively.

Data analysis

Data were double-entered and verified in Epi-Info version 6.04 and analysed using SPSS

version 15.0 statistical software (IBM, USA). The children were categorised into anaemic (Hb ≤10g/dL) and non-anaemic groups. Means and standard deviations were used to summarise quantitative variables (age of children) and proportions of categorical variables were analysed using the χ^2 test and Yates correction (where necessary). The prevalence of each variable was determined for each group (anaemic and non-anaemic). The *p*-value (*p*<0.05) was used to determine statistically significant associations.

Results

Socioeconomic and demographic characteristics of the subjects

Most (92.8%) of the respondents (caregivers) were mothers, and most (69.5%) of these had tertiary education. The presence of anaemia correlated inversely with educational level of the parents/caregivers (*p*=0.04). The predominant occupation of the caregivers was civil service (33.7%), followed by being unemployed (24.6%). There was a significant association between occupation of the caregivers and anaemia. One-third of caregivers (35.4%) was classified as being

Table 1. Age distribution of subjects diagnosed with anaemia

Age groups (months)	Anaemic, <i>n</i> (%)
6 - 12	76 (26.5)
13 - 36	146 (51.0)
37 - 59	64 (22.3)

Table 2. Risk factors associated with childhood anaemia

Risk factors	Anaemic children (N=286), <i>n</i> (%)	Relative risk, % (CI)	<i>p</i> -value
Malaria (<i>n</i> =256)	138 (48.3)	1.20 (1.01 - 1.41)	0.03
Serum iron (<9 μmol/L) (<i>n</i> =178)	121 (42.3)	1.66 (1.42 - 1.93)	0.01
TIBC (> 80 μmol/L) (<i>n</i> =138)	97 (33.9)	1.65 (1.41 - 1.92)	0.01
G6PD deficiency (<i>n</i> =120)	71 (24.8)	1.26 (1.05 - 1.50)	0.02
HIV seropositivity (<i>n</i> =59)	38 (13.3)	1.33 (1.08 - 1.65)	0.02
Haemoglobin genotype (SS) (<i>n</i> =10)	7 (2.4)	1.44 (0.93 - 2.13)	0.34*
Hookworm (ova) (<i>n</i> =4)	3 (1.1)	1.51 (0.86 - 2.71)	0.32*

CI = confidence interval.

*Yates correction.

Table 3. Anthropometric measures for the subjects

Variables	Anaemic children (N=286), <i>n</i> (%)	Relative risk, % (CI)	<i>p</i> -value*
Stunting (<3rd centile) (<i>n</i> =93)	45 (15.7)	0.98 (0.78 - 1.23)	0.82
Wasting (<3rd centile) (<i>n</i> =47)	18 (6.3)	0.76 (0.52 - 1.11)	0.10
Underweight (<3rd centile) (<i>n</i> =39)	17 (5.9)	0.88 (0.61 - 1.27)	0.51
MUAC ≤12.5 cm (<i>n</i> =30)	20 (7.0)	1.38 (1.06 - 1.80)	0.07

*Correlates with anaemia in children.

of low SES. There was no significant association between SES and anaemia.

Of the 652 children who participated, 581 children had complete questionnaires with investigation results, and these comprised the analysed sample. Male children were in a slight majority (54.9%). The overall prevalence rate of anaemia was 49.2%.

The prevalence of anaemia among children between the ages of 13 and 36 months was high (51%), and this was statistically significant (Table 1).

Malaria was present in 138 anaemic children (48.3%) and 118 non-anaemic children (40.0%) (relative risk (RR)=1.20, $p=0.03$) (Table 2). Low serum iron was detected in 121 anaemic children (42.3%) and 57 non-anaemic children (19.3%) (RR=1.66, $p=0.01$), while a high TIBC was found in 33.9% of anaemic children compared with 13.9% of controls (RR=1.65, $p=0.01$). G6PD deficiency was detected in 71 anaemic children (24.8%) and 49 non-anaemic children (16.6%) (RR=1.26, $p=0.02$).

HIV seropositivity was detected more frequently in anaemic children (13.3%) than non-anaemic children (7.1%) (RR=1.33, $p=0.02$).

Haemoglobin genotype SS was not found more frequently in anaemic children ($n=7$, 2.4%) than non-anaemic children ($n=3$, 1.0%) (RR=1.44, $p=0.34$).

Hookworm ova were detected in three anaemic children (1.0%) and one non-anaemic child (0.3%) (RR=1.51, $p=0.32$).

Table 3 shows that 45 anaemic children (15.7%) and 48 non-anaemic children (16.3%) were stunted, (RR=0.98, $p=0.82$). No association was found between wasting and anaemia (RR=0.76, $p=0.10$) or between underweight and anaemia (RR=0.88, $p=0.51$).

Twenty anaemic children (7.0%) and 10 non-anaemic children (3.4%) had a mid-upper arm circumference (MUAC) ≤ 12.5 cm. No significant association was found between low MUAC and anaemia (RR=1.38, $p=0.07$).

Discussion

In this study, the anaemia prevalence among paediatric patients <5 years of age was high, especially among children 13 - 36 months old. This is similar to what has been reported in other studies,^[17,27] and has been suggested to be a result of: malaria infection with poor immunity to malaria in this age group; nutritional anaemia due to poor complementary feeding practices;^[7,28] increase in body demand due to rapid growth; and increased activity due to achieved motor milestones. Anaemia was not associated with gender or SES. Different studies have reported contrasting views on the association between anaemia and gender,^[27,29] as well as SES.^[30,31] The reasons for these differences are not clear. The fact that this study was hospital based might have contributed to the observed differences. Most ill children from all socioeconomic groups might have sought care from different sources by the time they seek healthcare from the hospital. This delay in access of healthcare allows the underlying illness enough time to cause anaemia as a complication.

Malaria was significantly higher among anaemic paediatric patients, a finding reported by other studies^[12-14] but which is in contrast to expectation, as the region has seen an overall reduction in malaria burden.^[32] A possible explanation for this may be that although there has been an overall reduction in malaria burden in the community, the malaria burden in ill children <5 years old has not changed much. The practice of self-medication^[33] may have contributed to delay in appropriate health-seeking behaviour, and may have allowed enough time for malaria to cause anaemia through different mechanisms.^[34]

Iron deficiency was also found to be significantly associated with anaemia. This is similar to some previous studies,^[17,18] but contrary to the findings of Callis *et al.*^[11] and Cardoso *et al.*^[28] Iron-deficiency anaemia is sinister in young children.^[11] The International

Nutritional Anaemia Consultative Group (INACG) and WHO have recommended daily iron supplementation both for treatment and prophylaxis, especially for groups at risk.^[11] This intervention seems to be adequately implemented among pregnant women who attend antenatal care and among sickle cell anaemic children attending routine follow-up clinic visits, but little or no activity is noted among otherwise well children. This study has revealed the need to improve the practice of daily iron supplementation, especially for children <5 years of age.

There was a low prevalence of hookworm infections among both anaemic and non-anaemic paediatric patients <5 years of age. This supports other studies that reported no association between anaemia and the prevalence of hookworm in children <5 years of age,^[14,19] but in older age groups^[35] the prevalence of hookworm infections increases. The findings of this study support the design of the anthelmintic programme, which excludes children <5 years of age from treatment; according to the Deworm the World Initiative, the implementation of the deworming programme should be school based.^[36] However, there is still need for further study to determine the prevalence of other intestinal helminths among paediatric patients <5 years old. Although helminths may not be causing anaemia, they could contribute to other morbidity in young children.

Among the investigated paediatric patients, the prevalence of G6PD deficiency was high, and was significantly associated with anaemia, which contrasted with SCA – another haematologic genetic disorder that was found to have a low prevalence and no significant association with the prevalence of anaemia. This lack of association contrasts with the common assumption. However, it is insightful to note that although the prevalence of anaemia among SCA patients may be high, the prevalence of SCA among anaemic children was low. Therefore, the possibility of SCA being the contributing factor to anaemia among anaemic paediatric patients is very remote. This should influence the prioritisation of investigations, especially in sub-Saharan regions, where the poverty rate is high and iron deficiency is very common.

In this study, HIV prevalence among anaemic paediatric patients was low, at 13%, but it was significantly associated with anaemia. This is different from what other studies have reported.^[13,15,16] Few studies have investigated the prevalence of HIV among anaemic children <5 years of age. The current finding does not disprove the potential of HIV to cause anaemia, but highlights that HIV/AIDS is not among the common causes of anaemia among paediatric patients.

Indicators of malnutrition were not found to be significantly associated with anaemia in paediatric patients in this study. This association has been reported by Callis *et al.*,^[11] but contrasts with the findings of Bernal *et al.*^[37] and Ngnie-Teta *et al.*^[38] There is no clear explanation for these reported differences, but it is likely that anthropometric measurements poorly reflect micronutrient status such as those of iron and folate, which are better assessed biochemically.^[39,40]

A limitation of the study was the lack of bacteriological studies. A blood culture would have shown the prevalence of sepsis among children with anaemia, since bacterial infection is common in sub-Saharan African regions.

Conclusion

This study has shown that multiple factors contribute to anaemia in paediatric patients in Nigeria. Among these multiple causes, malaria and iron deficiency remain the major contributing factors. Therefore, in every child that presents with anaemia, an effort should be made to exclude malaria and iron deficiency. Furthermore, boosting malaria control programmes and promotion of iron supplementation programmes can reduce the burden of anaemia in Nigeria.

Acknowledgements. We are grateful to all the caregivers who allowed their children to be part of the study. The authors are thankful to the resident doctors in the Department of Paediatrics for their collaboration in the work.

References

- Chapler CK, Cain SM. The physiologic reserve in oxygen-carrying capacity: Studies in experimental hemodilution. *Can J Physiol Pharmacol* 1986;64(1):7-12.
- World Health Organization. Worldwide prevalence of anaemia 1993-2005. WHO Global Database on Anaemia. Geneva: World Health Organization, 2008.
- Murray CJL, Lopez AD. The global burden of disease: A comprehensive assessment of mortality and disability from diseases, injury and risk factors in 1990 and projected to 2020. In: Murray CJL, Lopez AD. *Global Burden of Disease and Injury series*, Vol. 1. UK: Harvard University Press, 1996:1-43.
- Koram KA, Owusu-Agyei S, Utz G, et al. Severe anaemia in young children after high and low malaria transmission seasons in the Kassena-Nankana district of northern Ghana. *Am J Trop Med Hyg* 2000;62(6):670-674.
- Anumudu CI, Okafor CM, Ngwumohaike V, Afolabi KA, Nwuba RI, Nwagwu M. Epidemiological factors that promote the development of severe malaria anaemia in children in Ibadan. *Afr Health Sci* 2007;7(2):80-85.
- National Heart, Lung, and Blood Institute. What Causes Anaemia? <http://www.nhlbi.nih.gov/health/health-topics/topics/anaemia/cause/html> (accessed 13 April 2009).
- Tagbo BN, Ughasoro MD. Complementary feeding pattern of infants attending the University of Nigeria Teaching Hospital (UNTH), ItukuOzalla, Enugu. *Niger J Paediatr* 2009;36(3&4):51-59.
- McAuley CF, Webb C, Makani J, et al. High mortality from *Plasmodium falciparum* malaria in children living with sickle cell anemia on the coast of Kenya. *Blood* 2010;116(10):1663-1668. [<http://dx.doi.org/10.1182/blood-2010-01-265249>]
- Kreuzer KA, Rockstroch JK. Pathogenesis and pathophysiology of anaemia in HIV infection. *Ann Hematol* 1997;75(5-6):179-187.
- Fleming A. Anaemia in Northern Nigeria and two South African cities. In: Nestel P, ed. *Iron Interventions for Child Survival*. Proceedings, May 17-18, 1995, London. Arlington, USA: John Snow (JSI) Opportunities for Micronutrient Intervention (OMNI), 1995:139-142.
- Callis JC, Phiri KS, Faragher EB, et al. Severe anaemia in Malawian children. *N Eng J Med* 2008;358(9):888-899. [<http://dx.doi.org.10.1056/NEJMoa072727>]
- Akhwale WS, Lum JK, Kaneko A, Eto H, Obonyo C, Björkman A, Kobayakawa T. Anaemia and malaria at different altitudes in the western highlands of Kenya. *Acta Trop* 2004;91(2):167-175. [<http://dx.doi.org/10.1016/j.actatropica.2004.02.010>]
- Schellenberg D, Armstrong-Scelenberg JRM, Mushi A, et al. The silent burden of anaemia in Tanzanian children: A community-based study. *Bull World Health Organ* 2003;81(8):581-590.
- Omeregbe R, Eghafona NO. Effect of urinary tract infection on the prevalence of anaemia among HIV patients in Benin City, Nigeria. *N Z J Med Lab Sci* 2009;63(2):44-46.
- Stoltzfus RJ, Chwaja HM, Montresor A, Albonico M, Savioli L, Tielsch JM. Malaria, hookworms and recent fever are related to anaemia and iron status indicators in 0- to 5-yr-old Zanzibari children and these relationships change with age. *J Nutr* 2000;130(7):1724-1733.
- Kaur S, Deshmukh PR, Garg BS. Epidemiological correlates of nutritional anaemia in adolescent girls of rural Wardha. *Ind J Com Med* 2006;31(4):10-12.
- Muhangi L, Woodburn P, Omara M, et al. Associations between mild to moderate anaemia in pregnancy and helminth, malaria and HIV infection in Entebbe Uganda. *Trans R Soc Trop Med Hyg* 2007;101(9):899-907. [<http://dx.doi.org/10.1016/j.trstmh.2007.03.017>]
- Lagos State Ministry of Health. Malaria Control Programme. <http://www.lsmoh.com>. (accessed 23 October 2013).
- Stoltzfus RJ, Dryfuss ML, International Nutritional Anemia Consultative Group (INACG). Guidelines for the use of iron supplements to prevent and treat iron deficiency anaemia. <http://www.who.int> (accessed 11 April 11 2012).
- Enete IC, Alabi MO. Observed urban heat island characteristics in Enugu urban during the dry season. *Glob J Human Soc Sci* 2012;12(10):74-80.
- Oyedemi GA. Socioeconomic and cultural background of hospitalised children in Ilesha. *Nig J Paediatr* 1995;12:111-117.
- Von Schenck H, Falkensson M, Lundberg B. Evaluation of "HemoCue", a new device for determining haemoglobin. *Clin Chem* 1986;32(3):526-529.
- Siek G, Lawlor J, Pelczar D, Sane M, Musto J. Direct serum total iron-binding capacity assay suitable for automated analyzers. *Clin Chem* 2002;48(1):161-166.
- Al-Buhairam AM, Oluboyede OA. Determination of serum iron, total iron binding capacity and serum ferritin in healthy Saudi adults. *Ann Saudi Med* 2001;21(1-2):100-103.
- Bain BJ. Basic haematological techniques. In: Dacie JV, Lewis SM, eds. *Practical Haematology* (8th ed.). New York; Churchill Livingstone Inc., 1995:49-82.
- White JM, Frost BA. Investigation of the haemoglobinopathies. In: Dacie JV, Lewis SM, eds. *Practical Haematology* (8th ed.). New York; Churchill Livingstone Inc., 1995:179-199.
- Siegel EH, Stoltzfus RJ, Khatry SK, LeClerg S, Katz J, Trellsch JM. Epidemiology of anaemia among 4 to 7 months children living in South-central Nepal. *Eur J Clin Nutr* 2006;60(2):228-235. [<http://dx.doi.org/10.1038/sj.ejcn.1602306>]
- Cardoso MA, Scopel KKG, Muniz PT, Villamor E, Ferreira MU. Underlying factors associated with anaemia in Amazonian children: A population-based, cross-sectional study. *PLoS ONE* 2012;7(5):e36341. [<http://dx.doi.org/10.1371/journal.pone.0036341>]
- Pasricha SR, Black J, Muthayya S, et al. Determinants of anaemia among young children in rural India. *Pediatrics* 2010;126(1):e149-149. [<http://dx.doi.org/10.1542/peds.2009-3108>]
- Animasahun BA, Temiye EO, Ogunkunle OO, Izuora AN, Njokanna OF. The influence of socioeconomic status on the hemoglobin level and anthropometry of sickle cell anaemia patients in steady state at the Lagos University Teaching Hospital. *Niger J Clin Pract* 2014;14(4):422-427. [<http://dx.doi.org/10.4103/1119-3077.91748>]
- Keikhaei B, Zandian K, Ghasemi A, Tabibi R. Iron-deficiency anaemia among children in Southwest Iran. *Food Nutr Bull* 2007;28(4):406-411.
- Tagbo O, Henrietta UO. Comparison of clinical, microscopy and rapid diagnostic test methods in the diagnosis of *Plasmodium falciparum* malaria in Enugu, Nigeria. *Niger Postgrad Med J* 2007;14(4):285-289.
- Thera MA, D'Alessandro U, Thiérou M, et al. Child malaria treatment practices among mothers in the district of Yanfolila, Sikasso region, Mali. *Trop Med Int Health* 2000;5(12):876-881.
- Hassan K, Sullivan KM, Yip R, Woodruff BA. Factors associated with anaemia in refugee children. *J Nutr* 1997;127(11):2194-2198.
- Adeyeba OA, Tijani BD. Intestinal helminthiasis among malnourished school-age children in peri-urban area of Ibadan, Nigeria. *Afr J Clin Exp Microbiol* 2002;3(1):24-28.
- Deworm the World Initiative, Evidence Action. GiveWell Real Change for Your Dollar. www.givewell.org (accessed July 2012).
- Bernal C, Velásquez C, Alcaraz G, Botero J. Treatment of severe malnutrition in children; Experience in implementing the World Health Organization Guidelines in Turbo, Colombia. *J Pediatr Gastroenterol Nutr* 2008;46(3):322-328.
- Ngnie-Teta I, Receveur O, Kuate-Defo B. Risk factors for moderate to severe anaemia among children in Benin and Mali: Insight from a multilevel analysis. *Food Nutr Bull* 2007;28(1):76-89.
- World Health Organization. Iron Deficiency Anaemia, Assessment, Prevention, and Control. A Guide for Programme Managers. http://www.who.int/nutrition/publications/micronutrients/anaemia_iron_deficiency/WHO_NHD_01.3/en/ (accessed 14 January 2014).
- Hettiarachchi M, Liyanage C. Dietary macro- and micro-nutrient intake among a cohort of pre-school children from southern Sri Lanka. *Ceylon Med J* 2010;55(2):47-52.