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Hematological Parameters of Malnourished Sudanese Children Under 5 Years – Khartoum State – 2011

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Abstract

Malnutrition is one of health problems in developing countries in particular. Maternal and child health centers are often not available in many areas in Sudan. This study aimed to determine complete blood count of malnourished Sudanese children bellow 5 years of age (2011). 27 males and 23 females malnourished pediatric patients were enrolled in this study. Twenty apparently healthy with matched age subjects were selected as control group. An informed consent was obtained from participants parents before blood sample collection. Five ml venous blood was collected from each participant, 2.5 ml was collected in EDTA container for CBC determination, and 2.5 ml was collected in plain container for serum iron and serum ferritin measurement. Hematological analyzer Sysmex KX 21N was used for CBC measurement. A-25 Biosystem was used for determination of serum iron. SPSS software program was used for statistical analysis, significance level was set at $p \leq 0.05$. 58% of test group with age bellow 18 months and 42% above 18 months. Marasmus was observed in 82% of malnourished children. ALL hematological parameters of malnourished children was significantly different compared to control group. Hemoglobin decreased from 15.12 ±1.1 g/dl in control group to 8.8 ± 2.5 g/dl in test group. Blood platelet count and WBC of test group significantly increased compared to control ($p < 0.00$). WBC increased from $5.1 \pm 0.98 \times 10^3$ µl in control to $12.2 \pm 5.2 \times 10^3$ in test group. Serum iron and serum ferritin of malnourished children significantly decreased compared to control group. Serum iron decreased from 99.3 ± 27.6 µg/ dl to 43.9 ± 32.9 µg/ dl in control and test groups respectively ($p < 0.00$). In conclusion, marasmus is the major type of malnutrition among study group. Malnutrition significantly alters hematological status of test group. Iron deficiency and infections are frequently associated with malnutrition.

Keywords

Malnutrition, Marasmus, Hemoglobin, Iron, Ferritin

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1. Introduction

Approximately 826 million of people in the world are undernourished, 792 million people in the developing world and 34 million in the developing world [1]. Malnutrition plays a major role in over one – third of all child deaths worldwide [2]. Various studies in Sub-Sahara Africa reported that about 50% of under five deaths can be attributed to malnutrition, and the contribution of malnutrition to mortality in children with diarrhoea, pneumonia, measles and malaria has been well documented [3]. PEM is a major global public health problem affecting children from Africa, Asia, Latin America. PEM is responsible for about 10 million deaths per year among children under 5 years in developing countries [4] Severe acute malnutrition is common in developing countries. Marasmus is a serious worldwide problem that involves more than 50 million children younger than 5 years. According to WHO, 49 % of 10.4 million deaths occurring in children younger than 5 years in developing countries are associated with PEM [5]. Prevalence of child malnutrition is

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about twice as high in Eriteria and Ethiobia (40 % underweight as in Kenya and Uganda 20%). [6] In Sudan, prevalence of underweight children under 5 years was 31% (medium) and 9.4 % (severe). In Southern Sudan in 2004 (before Republic of Southern Sudan establishment), the prevalence of malnourished children under 5 years was 48% [7].

Children with severe malnutrition are prone to complications including electrolyte imbalance and infections [8]. In Uganda, malnourished children with age ranged between 12 to 24 months showed high prevalence of infections, pneumonia (68%), diarrhea (38%), urinary tract infection (26%), and bacteraemia (18%) [9]. In tropical countries including Sudan, malaria and malnutrition are still major health problem [7].Table 1 showed the number of malnourished children recorded in Omdurman Paediatrics Hospital [10].

Table 1. Cases of malnourished children Attended Omdurman Paediatrics Hospital (2011).

Year	2005	2006	2007	2008	2009	2010
No. of malnourished children	2721	2011	1629	1130	978	1133

**Omdurman Paediatrics Hospital, Statistical Services (2011).*

According to table 1, cases of malnourished children decreased gradually from the year 2005 to 2010, this could be due to efforts of health authorities regarding the continuous follow up of malnourished children particularly in Khartoum State (the Sudan Capital) where a specialised clinic was established which receives children with malnutrition only and offers them special treatment.

In Sudan poor child feeding practices are a problem across the country in Kassla and Algagerif State [11]. According to American Academy of Pediatrics, full term healthy exclusively breastfed infants should receive iron supplements beginning at 4 months of age. Children should absorb 1 mg iron / day to keep up with their needs of their growing bodies. Although infants were born with iron stores for the first 4 months, but breast milk itself contains very little iron.. For these reasons, 80 % of children in developing countries become anemic at some point during their childhood and adolescence and iron deficiency is common among children [12]. So, Africa and Asia are the most affected regions with more than 85% of the absolute anemia burden. Children and women of reproductive age are most at risk; with global anemia prevalence estimates of 47% in children less than 5 years and 42 % in pregnant women [13] Poor nutritional status of children is a major health problem throughout the developing world, and the underlying cause for 35% of child deaths and 11% of the total global disease burden. The global burden of childhood mortality, morbidity and under nutrition is now increasingly concentrated in the most deprived and underserved populations within countries [14].

Alteration in in the hematological functions in malnutrition have been documented. Severe protein energy malnutrition is associated with the depletion of the hematological and lymphocyte subsets [9].

Malaria and anemia (Hb < 11g/dl), remain frequent in tropical regions and are closely associated [13].

Severely malnourished children has reduced serum iron profile. Parasitic infection influenced the marked reduction of mean serum iron concentration and transferrin saturation level. Serum ferritin concentration are lower than normal and elevated in all types of infection. So, serum iron, transferrin saturation < 16% constitutes good evidence for iron deficiency in both infected and non- infected severely malnourished children [15]. Although low serum iron ferritin reflects total iron body reservoirs but it is an indicative of iron deficiency but ferritin is an acute phase protein and elevated in infection and it is not reliable marker of human iron status in the presence of infection or inflammation [16].

Various authors correlate blood platelet activation with infections and concluded that Platelet destruction occurs in infection and hypercoagulable state is associated with platelets activation exists in P-falciparum infection [17].Moreover, blood platelet has immunological functions and participate in the interaction between pathogens and host defenses [18]. Other studies revealed that some platelets functions (ADP and collagen - induced platelets aggregations) have been decreased in protein energy malnutrition [19].

2. Materials and Methods

This is a case control study conducted at Khartoum and Omdurman Teaching Hospitals and AL Bulk Pediatric Hospital (2011). The study aimed to determine Complete Blood Count of Sudanese Pediatric Patients.

Inclusion criteria: children with age below 5 years, and newly diagnosed as malnourished and before receiving treatment.

Exclusion criteria: malnourished children above 5 years of age, and malnourished children under treatment.

Ethical consideration: a verbal consent was obtained from parents of test group before sample collection. A designed questionnaire was constructed to collect demographic data.

Study population: fifty malnourished children bellow 5 years and 20 apparently healthy children with age bellow 5 years

were enrolled in the study.

Five ml venous blood was collected, 2.5 ml was collected in EDTA container and 2.5 was collected in plain container and serum was obtained and stored at –20ºC until used. Automated Hematological Analyzer Sysmex KX-21 for determination of CBC and A –25 Biosystem for determination of serum iron (spectrophotometry) and serum ferritin (turbitimary).

SPSS software program was used for t-test and ANOVA. P-value significance level was set at $p \leq 0.005$.

3. Results

Table 2. Distribution of malnourished children according to age.

Age (months)	No of subjects	
> 18	29	58 %
18-36	17	34 %
< 36	4	8 %
Total	50	100 %

According to table 2: 58% of test group with age bellow 18 months. 27 were females and 23 were males.

Table 3. Distribution of study population according type of malnutrition.

Type of malnutrition	No of subjects	
Kwashiorkor	6	12 %
Marasmus	41	82%
Kwashiorkor and Marasmus	3	6 %
Total	50	100 %

Marasmus was the main type of malnutrition, where it constituents 82 %. (table 3)

Table 4. Hematological Parameters of study group compared to control.

Parameter	Mean ± SD		P-value
	Test = 50	Control = 20	
Hemoglobin (g/ dl)	8.8 ± 2.5	15.12 ± 1.1	0.000
MCV (fl)	71.98 ± 12.0	85.6 ± 4.4	0.000
Hct (%)	28.7 ± 7.2	43.7 ± 4.5	0.000
MCH (pg)	22.5 ± 4.8	27.9 ± 2.2	0.000
MCHC (g/dl)	30.9 ± 2.2	33.9 ± 1.8	0.000
PLT × 10^3 (µl)	570.0 ± 500	240.0 ± 80	0.000
WBC × 10^3 (µl)	12.2 ± 5.2	5.1 ± 0.98	0.000
Serum iron (µg/dl)	43.9 ± 32.9	99.3 ± 27.6	0.000
Serum ferritin (µg/l)	17.9 ± 17.1	95.3 ± 81.9	0.000

Significant difference in the hematological parameters was observed between test and control groups ($p = 0.000$). Hb level, Hct, MCH and MCHC of test group significantly decreased compared to control. WBC and blood platelets significantly increased compared to control. (table 4). Serum iron and serum ferritin of test group decreased significantly compared to control.

4. Discussion

The results of this study revealed that malnutrition starts in early childhood, this is shown in table 2. where 58 % of test group bellow 18 months of age. Similar findings was reported by [3] who reported that various studies in Sub-Sahara Africa report that about 50% of under five deaths can be attributed to malnutrition. 54% were males and 46 % were females.

According to table 3, marasmus is the common type of malnutrition among Sudanese paediatric individuals. This could be related to deficiency in iron which is a co- factor for mitochondrial energy generation and supports growth and differentiation of all cell types [20]. Similar findings concluded that marasmus is a serious problem and is most common in developing regions, as Africa, Latin America and South Asia, where poverty along with inadequate food supplies and contaminated water are prevalent. Contaminated water may contain bacteria where water is consumed and causes infections that complicates the condition [21].Furthermore, marasmus is most frequently associated with infections [5].

The current study showed significant differences between the hematological parameters of malnourished children compared to control group (table 4). Hb, Hct and RBC indices significantly decreased which was confirmed by [22] who concluded that PEM results in various changes in the hematological profile. Low RBC resulting in anemia. Various factors contribute to anemia of malnutrition 1/ iron deficiency 2/ reduced red cell production in adaptation to lean smaller body mass. 3/ erythropoietin deficiency 4/ folic acid and vitamin B_{12} deficiency 5/ deficiency in trace element (copper or zinc), 6/ infections.

Iron deficiency is the most common trace element deficiency worldwide, affecting 20% to 50% of the world, s population mainly infants and children and women of child bearing age [1]. Severe acute malnutrition is associated with increased severity of common infectious diseases and death among children with severe acute malnutrition is almost always as a result of infection such as malaria [23].

Serum iron and serum ferritin of test group significantly decreased compared to control which indicated iron deficiency anemia, this was confirmed by some studies in India [24, 15] which revealed that mean serum iron and mean serum ferritin of malnourished children with acute respiratory infection is significantly lower than normal [24]. Severely malnourished Indian children has reduced mean serum iron profile, this reduction could be due to parasitic infection, serum ferritin concentration was also reduced compared to control, but elevated in all types of infection [15]. Another study in Nigeria revealed that Hb, PCV and serum ferritin was significantly lower in PEM children bellow 10 years compared to control ($p < 0.05$).Iron stores of PEM

children significantly reduced ($p < 0.05$) compared to control. Serum iron and transferrin saturation of the test group is higher significantly compared to control ($p < 0.05$) [20]. These indicated that iron deficiency anemia is often associated with malnutrition which is confirmed by [13].

In Sudan, Iron deficiency anemia may be due to many reasons, feeding practices, since in Sudan poor child feeding practices are a problem across the country in Kassla and Algagerif State [11] and artificial milk may be introduced which contains no active lactoferrin [25]. Although cow's milk contains low iron and may cause intestinal disorders in some instants that may lead to blood loss and interfere to iron absorption [12] but it is the major type of milk consumed by many Sudanese families.

In developing countries such as Sudan, maternal and antenatal care clinics are not available in many areas which make clinical follow up for both pregnant women and neonates difficult. Moreover, low socio economic status of most of Sudanese families could be another leading cause of malnutrition as reported by [14], who concluded that the global burden of childhood mortality, morbidity and under nutrition is now increasingly concentrated in the most deprived and underserved populations within countries. Displacement in addition to drought worsen the situation of this target group. However, nutritional deficiency and associated infections particularly malaria was expected. This was confirmed by some previous studies which concluded that 40 % of pre-school children and 50 % of pregnant women in the developing countries are iron deficient [16]. The same author reported that iron deficiency and malaria are significantly co- morbidities in large proportions of the developing world, and both melodies affect pregnant women and children [16]. Furthermore, malnutrition is known to be a factor associated with anaemia, particularly in vulnerable group living in low income countries can contributes to malnutrition and anemia [13].

Significant elevation of WBC count of test group compared to control was observed (table 4), these expected results were similar to previous studies which stated that malnutrition and infection are significantly correlated and about 11 million children under the age of 5 years die from infections and malnutrition [9].Other study concluded that five infectious diseases account for more than one - half of all deaths in children aged bellow 5 years, most of whom are undernourished. Pneumonia, diarrhoea, inflammation, measles and malaria. An adequate dietary intake leads to weight loss, lowered immunity and invasion by pathogens and malnutrition predisposes to infection and increases the severity and mortality of infections and malnutrition and infections tend to occur in the same population: resource poor settings and poverty [1].

The current results showed that blood platelet count significantly increased in malnourished children compared to control. Some studies correlate platelet activation with malaria infection and Plasmodium can interact with different receptors on human platelet which shortened their life span and pathogens can induce removal of platelets from the circulation by stimulating their sequestration in organs or by triggering their clearance by phagocytosis, which explain thrombocytopenia commonly associated with malaria [18].

Other studies concluded that platelet reactivity depends on the hemoglobin levels rather than the iron parameters with a significant correlation between hemoglobin or serum iron and transferrin saturation on one hand and parameters of platelet aggregation on the other hand ($p < 0.001$) [26].

5. Conclusion

Marasmus is the common type of PEM among Sudanese children under 5 years, affecting both males and females. Hematological status of test group was significantly altered compared to control. Infections and feeding practices together with low socio - economic status of majority of Sudanese families are leading causes of malnutrition among children.

Although most of Sudanese family members take the same type of food, but pregnant women and children should have special highly nutritive food. In addition, lactating mothers should be encouraged to breast fed their infants. Health policies are highly recommended in attempt to improve health status of pregnant women and neonates including establishment of maternal and child health centers in different areas.

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