

# 1 Haematological Profile in Children with Protein Energy 2 Malnutrition in North Central Nigeria

3 mohammed jimoh<sup>1</sup>

4 <sup>1</sup> University of Ilorin Teaching Hospital, Ilorin.

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## 7 **Abstract**

8 Background : Protein Energy Malnutrition (PEM) is associated with various changes in the  
9 body systems including changes in the haematologic system. These changes affect all the  
10 blood cells.. Observations about haematological changes in this group of children have been  
11 inconsistent due to frequent and constant changes in haemopoiesis resulting from this  
12 condition. This has limited the usefulness of these parameters in the anticipatory care of these  
13 patients thus the need to describe and validate the changes and possible haematological  
14 disturbance among children with PEM informed this study in Ilorin, North-central Nigeria.

15 Methodology : All children admitted into the Emergency Paediatric Unit (EPU) with a  
16 diagnosis of PEM were enrolled over a period of one year (January â???" December 2009).  
17 Controls were well children attending the routine clinic without haematologic or infectious  
18 condition. Haematological profiles were determined using auto-analyzer SMX 60. Data entry  
19 and analysis were carried out with a micro-computer using the Epi info version 3.5 (2008)

20 software packages and p value of  $< 0.05$  was regarded as significant. Results : Ninety children  
21 with PEM and 90 age and sex matched controls were studied. Children with PEM had lower  
22 mean values for haemoglobin, haematocrit and mean corpuscular haemoglobin ( $p<0.05$ ) when  
23 compared with controls. The mean value of WBC in the children with PEM was  $12.8 \pm 11.6$   
24  $\times 10^3$  cell/mm<sup>3</sup> while it was  $5.9 \pm 8.7 \times 10^3$  cell/mm<sup>3</sup> among the controls( $p= 0.001$ ). The  
25 mean value of platelet counts were  $291.8 \pm 131.7 \times 10^9 / L$  and  $326.4 \pm 133.9 \times 10^9 / L$  for  
26 the subjects and controls respectively ( $p=0.0001$ ). A statistical significant difference was  
27 observed in the lymphocyte count of the various classes of PEM with the edematous forms  
28 having higher counts ( $p= 0.0001$ ). Conclusion / Recommendation : In conclusion, Children  
29 with Protein Energy Malnutrition had lower red cell indices and platelet count, and a higher  
30 white cell count than the co

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32 **Index terms**— Children, Protein Energy Malnutrition, Haematologic profiles.

## 33 **1 Haematological Profile in Children with Protein**

34 Energy Malnutrition in North Central Nigeria Saka A.O ? , Saka M J ? , Ojuawo A ? , Abdulkarim Aa ? ,  
35 Bilamin Sa ¥ , Latubosun L §

## 36 **2 & Adeboye Man ?**

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### 3 CONCLUSION / RECOMMENDATION : IN CONCLUSION, CHILDREN WITH

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53 statistical significant difference was observed in the lymphocyte count of the various classes of PEM with the  
54 edematous forms having higher counts ( $p= 0.0001$ ).

### 55 3 Conclusion / Recommendation : In conclusion, Children with

56 Protein Energy Malnutrition had lower red cell indices and platelet count, and a higher white cell count than the  
57 controls. Also the edematous forms of PEM had higher granulocyte and lymphocyte counts when compared to  
58 the non edematous forms.

59 The study hereby recommends that more frequent studies be carried out to describe in more details the trend  
60 of protein Energy Malnutrition (PEM), is defined as a spectrum of diseases arising as a result of an absolute, or  
61 relative deficiency of calories and or protein in the diet 1,2 . It is globally the most important risk factor for  
62 illness and death, with hundreds of millions of young children affected 3 .

63 According to UNICEF in 2005, malnutrition was associated with approximately 50% of child deaths worldwide  
64 4 . It has been estimated that PEM affect every fourth child in the developing world 4 , with the regional prevalence  
65 for the severe forms ranging from 1-7% 5 . It is associated with 49% of the 10 million deaths occurring in children  
66 in the developing world and 52% of all under five deaths in Nigeria 6 , with 24% and 16% of the total under-5  
67 Nigerian population estimated to have suffered from mild-moderate and severe malnutrition respectively from  
68 1973 to 1983 7 , 8 . The hospital based incidence of severe PEM in Nigeria varies from 3.18% in Ilorin 9 . 4.39%  
69 in Ibadan8 and 4.5% in Ife 10 .

70 Protein Energy Malnutrition results in various changes in the body including changes in haematologic profile  
71 of the body. Low red cell count resulting in anaemia has always been a constant feature of protein energy  
72 malnutrition and may be normochromic normocytic, microcytic hypochromic, or, macrocytic ??1,12. The  
73 anaemia of malnutrition may be attributable to various factors such as iron deficiency, and /or reduced red cell  
74 production in adaptation to a smaller lean body mass 2,12 . Erythropoietin deficiency, deficiencies of vitamins  
75 (folic acid, B12,) or trace elements (copper, zinc), infections and chronic diseases have also been implicated  
76 2,12,13 .

77 White cell changes seen in protein energy malnutrition varies and such changes have been attributed to  
78 various factors. These include the synergist relationship which PEM has with infections and thymic atrophy seen  
79 in children with PEM 16 .

80 This paper set to validate existing literature on these changes especially in a condition where possible  
81 Introduction adaptational changes development can occur frequently. It will also evaluate further , possible  
82 haematologic changes in the sub classes of protein energy malnutrition.

83 The study was a case control study carried out at the University of Ilorin Teaching Hospital among children  
84 (6 -59 months old) with PEM and controls were children with normal nutritional status without haematological  
85 or infectious conditions. All consecutive admissions into the Emergency Paediatric Unit with a diagnosis of PEM  
86 based on the Wellcome classification that fulfilled the inclusion criteria were enrolled. Controls were well children  
87 attending the routine clinic without haematologic or infectious condition. Children with history suggesting  
88 ongoing haemolysis and haemoglobinopathies were excluded.

89 The minimum calculated sample size with 10% attrition rate was 90, thus 90 subjects each were selected for  
90 the study and control groups with a total of 180 participants for the study.

91 A semi-structured questionnaire (proforma) was used to obtain information from the subjects using interview  
92 method. Relevant information on the child's socio-demographic characteristics, nutritional indices and laboratory  
93 findings were documented.

94 Study participants were grouped into upper, middle and lower socioeconomic classes based on the Oyedele  
95 socio -economic classification scheme 13 .

96 Under aseptic conditions, after cleaning the venepuncture site with 70% alcohol, 5ml of venous blood was  
97 collected by venepuncture using a fixed hypodermic needle. The blood specimen was decanted into a sample  
98 bottle containing ethylene diamine tetra acetate (EDTA) and gently mixed to prevent clotting. The sample was  
99 analysed using an automated blood analyzer model/Symax KX 21® .

100 Data entry and analysis were carried out with a micro-computer using the Epi info version 3.5 (2008) software  
101 packages .Chi-square test and student t-test were used to test for statistical significance of the difference for

102 discreet and continuous variable respectively. A p value of < 0.05 was regarded as significant. Analysis of  
103 variance (ANOVA) was used for some comparisons.

104 The study was approved by the Ethics and Research Committee of the University of Ilorin Teaching Hospital.  
105 Informed consent was obtained from the parents/caregivers of participants.

106 A total of 180 children -90 with Protein Energy Malnutrition and 90 controls-were studied. Among the PEM  
107 group, 59 (65%) were males and 31 (34.4%) were females with a male to female ratio of 1.9:1. The mean age  
108 of the children with PEM was  $22.7 \pm 14.4$  months compared to  $29.3 \pm 16.9$  months for the controls and the  
109 difference was not significant ( $p=0.08$ )(Table 1).

## 110 4 Results

111 Thirty eight (42%) of the children with PEM were in socio-economic class (SEC) IV, 26 (28.8%) in SEC III,  
112 18(20%) in SEC V and only 2(2.2%) in SEC I. The subjects were of a lower socioeconomic class compared to the  
113 controls ( $p=0.00001$ )(Table 1).

114 Of the 90 mothers interviewed, 29 (32.2%) had primary education, 25 (27.8%) had no form of education, while  
115 21(23.3%) and 15(16.7%) had secondary and tertiary education respectively. The educational status of mothers  
116 of children with PEM were lower compared to that of controls ( $p=0.0002$ ) (Table ??).

117 The mean haematocrit values for the subjects and controls were  $30.4 \pm 6.3\%$  and  $32.0 \pm 6.1\%$  respectively  
118 while their mean haemoglobin values were  $10.1 \pm 2.1\text{g/dl}$  and  $10.9 \pm 15.0\text{g/dl}$  respectively and the difference  
119 was statistically significant ( $p=0.019$  and  $0.003$  respectively) with the subject having a lower value (Table  
120 ??) The mean values of the mean corpuscular volume were  $72.4 \pm 10.9\text{fl}$  and  $72.6 \pm 13.6\text{fl}$  in the subjects  
121 and controls respectively and the values were similar ( $p = 0.913$  ,while the mean values for mean corpuscular  
122 haemoglobin concentration and mean corpuscular haemoglobin were  $30.4 \pm 2.8\text{g/dl}$  RBC and  $24.3 \pm 10.5\text{fl}$  for  
123 subjects and  $0.3 \pm 1.8\text{ g/dl}$  RBC and  $25.6 \pm 1.6\text{g/dl}$  RBC, for controls and both were comparable ( $p>0.05$ ) (Table  
124 2),

125 The mean value of platelets count were  $291.8 \pm 131.7 \times 10^9 /L$  and  $326.4 \pm 133.9 \times 10^9 /L$  for the subjects  
126 and controls respectively and the difference was statistically significant ( $p=0.0001$ ) with PEM children having a  
127 lower platelet count compared to the controls(Table 2).

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130 The mean value of WBC in the children with PEM was  $12.8 \pm 11.6 \times 10^3 \text{ cell/mm}^3$  and  $5.9 \pm 8.7 \times 10^3 \text{ cell/mm}^3$   
131 among the controls ( $p= 0.001$ ) (Table 2). The subjects had higher mean values of total white cell count,  
132 neutrophil and lower lymphocytes counts compared with controls ( $p<0.05$ )(Table 2).

133 Children with Kwashiokor had the highest mean for haemoglobin, ( $31.6 \pm 1.6\text{g/dl}$ ) and haematocrit  
134 ( $10.7 \pm 0.4\%$ ), while subjects with marasmus had the lowest mean for haematocrit ( $27.6 \pm 5.8\%$ ), haemoglobin  
135 ( $9.1 \pm 2.1\text{g/dl}$ ) and mean corpuscular haemoglobin ( $22.9 \pm 2.3\text{pg/cell}$ ).(Table 2).

136 The subjects with kwashiokor and marasmic-kwashiokor had the highest lymphocyte counts while underweight  
137 had the lowest lymphocyte count with a statistical significant difference ( $p=0.0001$ ) (Table ??). Underweight  
138 children had the highest mean of white cell count ( $13.8 \pm 14.5 \times 10^3 \text{ cell/mm}^3$  ) while Marasmic -Kwashiokor  
139 had the lowest mean count, however, the difference is not statistically significant ( $p=0.750$ ). The neutrophils  
140 counts were similar in all the types of Protein Energy Malnutrition ( $p=0.438$ ) with subjects with kwashiokor  
141 having the highest value. (Table ??) Table ?? : Haematologic Profile of Children According to the Types of PEM.  
142 This study confirms that anaemia as well as high white cell count are near constant features of protein energy  
143 malnutrition as reported by previous studies. 10,14 Lower mean values were also observed in the haematocrit  
144 and haemoglobin values of children with PEM as compared to controls a finding similar to previous studies.  
145 10,14 Other red cell changes observed from this study includes a significantly lower mean values for MCH, MCV  
146 and RBC count in children with PEM when compared to the controls. These red cell changes can be attributed  
147 to adaptation to lower metabolic oxygen requirements and decrease in lean body mass seen in PEM. 15 These  
148 changes have also been attributed to changes in the plasma volume as well as the intracellular body water in the  
149 body. ??007B{0} An increase in plasma volume is seen and is said to be responsible for changes in haematocrit  
150 and haemoglobin levels while a concomitant decrease in intracellular water is said to be responsible for changes  
151 seen in MCHC. 23 Micronutrient deficiencies such as iron, zinc, have also been implicated. 2,12,13 This study  
152 also found a significant leucocytosis and neutrophilia among children with PEM as compared to controls, this  
153 is similar to a previous study where there was a significant rise in leukocyte count in the patients with PEM  
154 compared to the controls. 16 Leucocytosis in these children can be a result of infection which is seen commonly  
155 in PEM: both PEM and infection, either clinical or subclinical have been reported to act synergistically. 16  
156 This has been an important factor in determining morbidity and mortality attributed to PEM. 14 However,  
157 several other studies revealed leucopenia as well as neutropenia as a common finding in malnutrition. 16,21,22  
158 Furthermore, a lower lymphocyte count was observed in the malnourished children compared to controls. The  
159 lower lymphocyte count can be attributed to changes in the thymus which is greatly reduced in children during  
160 severe PEM. The degree of thymic atrophy correlates closely with depletion of lymphocytes and a decrease in  
161 the thymic dependent lymphocyte is also associated with impaired immunity. 17 However, among the various

## 8 AUTHORS CONTRIBUTION

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162 classes of PEM, the study found that children with the edematous forms of PEM had the highest mean values  
163 for neutrophils as well as lymphocytes count and a significant difference was observed in the lymphocyte count  
164 among the various classes of PEM. These findings are not in consonance with that of a previous study which  
165 found no difference in the lymphocyte count of children with malnutrition and concluded that a suppression in  
166 both granulocyte and lymphocyte functions occurred in malnutrition; 18 another study also reported lower white  
167 cell counts in Protein energy malnutrition. 19 The findings in this study can be explained by some possible  
168 adaptive mechanism which attempts to maintain some degree of immunocompetence in the edematous forms of  
169 malnutrition. This assumption can be corroborated by that of another study where CD4 counts were higher in  
170 malnourished children with edema compared to the non edematous types. 18 No significant changes were observed  
171 in the platelet of the various classes of PEM but there was a significant difference in the controls compared to  
172 PEM. Children with PEM had a significantly lower platelet count. This decrease in platelets seen in PEM can  
173 be attributed to a purported decrease in bone marrow activities which indirectly affect megakaryocyte functions.  
174 A similar finding has been reported by a previous study. 20 In conclusion, Children with PEM had lower red cell  
175 indices and platelet count, and a higher white cell count than the controls. Also the edematous forms of PEM  
176 had higher granulocyte and lymphocyte counts when compared to the non edematous forms of malnutrition.

177 Also, PEM is a condition that constantly modifies the body's defense mechanism and thus altering the  
178 haemopoiesis at all levels, thus this study recommends that more frequent studies be carried out to describe  
179 in more detail the trend of such changes in this part of the world. This would enhance anticipatory care and  
180 outcome of the children affected.

## 181 7 Global

## 182 8 Authors Contribution

VII. <sup>1 2</sup>



Figure 1:

1

Haematological

Figure 2: Table 1 :

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Figure 3: Table 2 :

183

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184 Saka AO, Ojuawo A, Abdulkarim and Adeboye MAN, were involved in conceptualizing the research work as  
185 well as carrying out the research work. Bilamin and Latubosun were involved in the laboratory analysis while  
186 Saka MJ was the biostatistician involved in study design, data collation as well as analysis.

187 The authors declare that we have no competing interest.

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