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Original Article

# Early detection of anemia among school children using the World Health Organization Hemoglobin Color Scale 2006

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## Abstract

***Background*** The high prevalence of anemic children in Indonesia is caused by the high incidence of diseases caused by parasitic infection such as malaria as well as iron deficiency. Early detection is needed for early intervention in order to allow optimal growth and development. A simple, economic, and practical tool for early detection of anaemic children is needed. The WHO recommended a Hemoglobin Color Scale as a suitable tool for the detection of anemia.

***Objective*** To assess the sensitivity, specificity, and predictive values of the WHO Hemoglobin Color Scale for early detection of anemic children.

***Methods*** A cross sectional diagnostic test was conducted in elementary school age children. Samples consisting of two drops of venous blood on paper were assessed by two observers (pediatrician & paramedic) using the Hemoglobin Color Scale to visually determine the level of hemoglobin. In addition, the hemoglobin level was also measured using a Hematology Analyzer to allow the visual test results to be compared to the results obtained using the gold standard of analysis. Agreement between these two methods of analysis was examined using the Cohen's kappa.

***Results*** Hemoglobin levels < 11.5 g/dL were detected in 15 of 124 (12%) elementary school children. The sensitivity, specificity, positive and negative predictive values when using the Hemoglobin Color Scale were 93%, 100%, 100% and 99% respectively for the first observer and 100%, 99%, 93%, and 100% respectively for the second observer. The Cohen's Kappa value was 0.76.

***Conclusion*** The WHO Hemoglobin Color Scale 2006 could be used as an early detection method for anemia in children. **[Paediatr Indones. 2009;49:135-8]**.

***Keywords***: *early detection, anemia, children, Hemoglobin Color Scale*

Anemia is still a major problem for many countries, with approximately two billion people in the world suffering from anemia.[1-4] The Household Health Survey 2001 reports Indonesia as an endemic area for malaria and helminthiasis where prevalence of anemia among school-age children and adolescents is 26.5%.[5] The most common cause of anemia among children in Indonesia is iron deficiency.[5] In the chronic condition, the clinical manifestations are fatigue, weakness and loss of concentration.[1-2] These are also linked with helminthiasis, malaria, and tuberculosis. Early detection of anemia is needed so that intervention can be performed to prevent high morbidity.[2]

There are several methods for anemia detection but most of them are not suitable for primary health care with minimum facilities as found in developing countries.[2] We need a method that is reliable, cheap,

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simple, quick and does not require electricity.[6] In early 1991, Talqvist's method was introduced. In this method, the degree of anemia is visually assessed by matching the color of a drop of blood on filter paper against a standardized color chart. The color chart was developed to represent the color range of normal to anemic blood on filter paper. The advantages of this method are that it is inexpensive, rapid, simple, portable, requires no reagents or electricity, and filter paper and color chart are durable if properly maintained and stored. However, it also has weaknesses, i.e., differences in the quality of the filter paper, methods of blood sample collection, and interpretation of the results by different observers.[3] Talqvist's method is still widely used in Indonesia, especially in Primary Health Centers. The WHO introduced a new method called the Hemoglobin Color Scale which was Talqvist's method. Previous studies indicated that its sensitivity ranged from 23% to 97% and specificity ranged from 47% to 98%. When used for detecting severe anemia, the sensitivity and specificity ranged from 50% to 94% and from 86% to 99% respectively. These indicate that this method is more sensitive than physical examination for diagnosis of anemia, especially in mild and moderate cases. Since 2006, the WHO recommended using this method for anemia screening and anemia management evaluation in developing countries.[7-10] We aimed to assess the specificity, sensitivity, and predictive values of the Hemoglobin Color Scale for early detection of anemia in elementary school children.

## Methods

A diagnostic test was conducted in Karangrejo Jogjakarta among randomly selected elementary school children. We included subject if he/she attended the school on the day of blood sampling, and excluded subjects whose the blood specimen was ravage. The gold standard was the level of hemoglobin determined by a Hematology Analyzer (HmX) at Pramita Diagnostic Laboratory in Jogjakarta.

The estimated sample size was determined using formula and results of previous study, resulting in a minimum of 124 subjects. Before the study was performed, Hemoglobin Color Scale Tools Kits were introduced to the two observers, a pediatric resident and a paramedic. They were trained how to perform the hemoglobin test using the color scale and how to interpret the results. After training, we performed a pilot study using 20 venous blood samples from the Clinical Pathology Laboratory at Dr. Sardjito Hospital. The specimens were assessed by the two observers using the color scale. The results of the visual assessment were compared with hemoglobin analysis results from the hematology analyzer (HmX).

A study was also performed to determine inter-observer agreement. Sixty two capillary blood samples (50% of minimum sample size) were collected from 62 pediatric outpatients in our department. The level of hemoglobin determined by the hemoglobin color scale was compared with the results from the Cohen's Kappa Analysis was performed to analyze inter-observer agreement. To ensure that excellent agreement was reached between the observers and the results from the hematology analyzer, the study was only started when the Kappa value reached 0.75.

Sampling was carried out after making an institutional agreement with the principal of Karangrejo elementary school. The parents of selected students were informed about the objective, methods, and advantages of our study so that they could give an informed consent.

Blood specimens were drawn by a trained paramedic from the median cubital vein in the antecubital fossa and transferred into EDTA-containing glass tubes that were sent to Pramita Diagnostic Laboratory for hemoglobin examination using a hematology analyzer (HmX) on the same day. Each blood specimen was also spotted onto two filter papers. After the papers had air-dried, each was assessed by the two observers for hemoglobin level using the color scale. The assessment of color has to be performed within 30 seconds of blood sampling under direct sunlight. The observers were blinded to the physical condition of the subjects, the assessment of the other observer, and the results from the Hematology Analyzer.

## Results

The study involved 124 subjects; 62 males and 62 females (Table 1). Using the gold standard hematology

analyzer method, 12.1% (15 of 124 samples) of subjects had hemoglobin levels less than 11.5 g/dL. We didn't find moderate or severe anemia. The lowest hemoglobin level was 10.3 g/dL and the highest level 13.9 g/dL (Table 1).

**Table 1.** Characteristics of patients at enrollment

| Characteristic | n=124 |
|---|---|
| Sex: | |
| Male, n (%) | 62 (50) |
| Female, n (%) | 62 (50) |
| Age, mean (SD), years | 9 (1.9) |
| Hb level, mean (SD), g/dL | 12.5 (0.789) |

The percentage of subjects with a hemoglobin level of less than 11.5 g/dL was determined to be 11.3% (14 of 124) by the first observer and 12.9 % (16 of 124) by the second observer. The mean hemoglobin level from HmX was 12.399 g/dL. The mean hemoglobin level from the first and second observer were 12.66 g/dL and 12.677 g/dL respectively. The difference in mean hemoglobin levels between HmX and the first observer was 0.3 (95% CI 0.065 to 0.459, P=0.010) and between HmX and the second observer was 0.3 (95% CI 0.725 to 0.484, P= 0.008).

The sensitivity, specificity, positive predictive value and negative predictive value of hemoglobin color scale for the first observer was 93%, 100%, 100%, and 99% respectively. The result for the second observer was 100%, 99%, 93%, and 100% respectively. The Cohen's Kapa between the first observer and the second observer from the pre experimental study was 0.76.

## Discussion

In Indonesia, especially in primary health care, hemoglobin measurement is still performed using the methods of Sahli or Talqvist.[6] The advantages of the Sahli method is that it is inexpensive, easy to perform and required no electricity. On the other hand, there are many disadvantages: 1) Being a visual method, it is subjective and error is very likely; 2) The color of the standard is not a true color match for the diluted blood. Graduated tubes must be cleaned between uses. Brown glass standard can fade with time; 3) a specific type of tube is needed; 4) the acid hematin method does not estimate total hemoglobin, only oxyhemoglobin and reduced hemoglobin; 5) The acid hematin is not a true solution. Some degree of precipitation may be present at the time of analysis and this may interfere with color matching. The sensitivity of this method is 85%.[6]

The advantages of Talqvist method are that is it inexpensive, rapid, easy to perform, portable, and no electricity is required. The disadvantages are : 1) the table is applied for limited filter paper; 2) calibrated paper is needed; 3) The scale might be contaminated with blood; 4) Lighting conditions can influence test result; 5) Size and thickness of blood spot, temperature, and humidity all affect drying time, which in turn affects color. The sensitivity and specificity are 60% at a hemoglobin level of 10 g/dL. The accuracy increases at hemoglobin levels < 9 g/dL.[6-10]

A study in Kenya in 2006 by Kim *et al* enrolled children from 2 months to 2 years old and pregnant women as the subjects. The study stated that this method has a sensitivity and specificity of 60% - 79% and 59% - 94% respectively. For severe anemia the sensitivity was 24% - 63% and the specificity was 97% - 100%. Paddle randomly selected 408 capillary blood samples drawn from subjects at the outpatients unit of the Royal Cornwall Hospital in London, UK in 2002, and compared the results from the color scale method with results from the HaemoCue Analyzer as the gold standard. The sensitivity of this study was 91% and the specificity was 86%. In 2000, Montessor *et al* carried out a study to detect anemia using a color scale method compared with a Digital Hemoglobinometer, where pre-school children were the subjects, The sensitivity was 85.2%and the specificity was 77.3%. Also in 2000, Ingram and Lewis randomly collected venous blood sample from 548 outpatients and determined the sensitivity and specificity as 92% and 86% respectively.[11-15] In this study, we found that sensitivity and specificity for the WHO Hemoglobin Color Scale test were 93% - 100% and 99% - 100% respectively, with high inter-observer agreement.

In conclusion, our study found that the WHO Hemoglobin Color Scale 2006 can be used as a tool for early detection of anemia in children in Indonesia.

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