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DIAGNOSTIC PERFORMANCE OF CBC-BASED PREDICTION FORMULAS FOR DETECTING BETA-THALASSEMIA MINOR COMPARED WITH HPLC IN HEBRON-PALESTINE

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Abstract

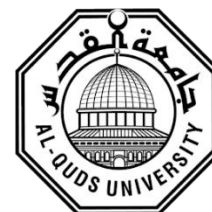
Background: Beta-thalassemia minor is a common hereditary blood disorder in Palestine and other Mediterranean regions. It usually presents as mild microcytic hypochromic anemia and can resemble other causes of microcytosis on complete blood count (CBC). Although hemoglobin analysis by HPLC or electrophoresis is the gold standard for carrier detection, these confirmatory tests are relatively expensive and not always easily available in limited-resource settings.

Early identification of carriers is particularly important in the context of premarital screening programs, as it helps reduce the risk of having children with severe forms of thalassemia. Therefore, CBC-based discriminant indices may offer a simple and cost-effective screening alternative for identifying suspected carriers.

Main Objective: To evaluate the diagnostic performance of selected CBC-based discriminant indices in detecting beta-thalassemia minor in comparison with hemoglobin electrophoresis

Methodology: A retrospective cross-sectional study was performed to evaluate CBC-based formulas in differentiating beta-thalassemia trait (BTT) from non-BTT individuals. Data were retrieved from the hospital and an accredited private laboratory records in Hebron, Palestine. The laboratory is accredited according to ISO standards.

For each participant, Hb-electrophoresis results and CBC parameters including hemoglobin (Hb), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and red cell distribution width (RDW) were recorded. The following discriminant indices were calculated: Mentzer index (MCV/RBC), Shine–Lal index, Sirdah index, and Green & King index. Based on Hb-electrophoresis results, the study population was categorized into two groups: individuals with confirmed BTT (HbA2 levels > 3.5%) (n = 71), and a normal control group (HbA2 < 3.5%) (n = 200).



Results: A total of 271 participants were included in this study, comprising 71 individuals diagnosed with beta-thalassemia trait (BTT) and 200 healthy controls. Significant differences were observed between the two groups in terms of age and sex distribution ($p < 0.05$). When applying standard cutoff values, the Shine-Lal index demonstrated the highest diagnostic performance, with sensitivity of 98.6%, specificity of 100%, accuracy of 99.6%, and an AUC of 1. The Mentzer index also showed excellent performance, with sensitivity of 88.7%, specificity of 99.5%, accuracy of 96.7%, and AUC of 0.996. The Sirdah index showed moderate performance, while the Green & King index had the lowest diagnostic accuracy, particularly due to its low specificity (25.5%) and accuracy (42.1%).

After recalculating optimal cutoff values based on the highest AUC and Youden's index, all indices showed improved diagnostic performance. The Shine-Lal index remained the best-performing formula, achieving 100% sensitivity, 99.5% specificity, 99.63% accuracy, and the highest Youden's index (0.995) at a cutoff value of <1595 . The Mentzer index followed closely with high sensitivity (95.77%), specificity (97.5%), and accuracy (97%).

Conclusion: Overall, the Shine-Lal index demonstrated superior diagnostic accuracy in differentiating beta-thalassemia trait from normal individuals, followed by the Mentzer index, while the Green & King index showed the least reliable performance.

Key words: Beta-thalassemia minor, Complete blood count (CBC), Discriminant indices, Mentzer index, Shine-Lal index, Sirdah index, Green & King index, Hemoglobin electrophoresis.