Correlation between normal glucose-6-phosphate dehydrogenase level and haematological parameters

S.K. Ajlaan,[1] L.M. Al-Naama [1] and M.M. Al-Naama [1]

العلاقة بين المستوى الطبيعي لنازعة هدروجين فسفات – 6 – غلوكوز وبين المتثابتات الدموية

سلمان كاظم عجلان ولمياء مصطفى النعمة ومنهل مصطفى النعمة

خلاصة: شملت هذه الدراسة 143 شخصاً بهدف تحديد العلاقة بين المستوى الطبيعي لنازعة هدروجين فسفات – 6 – غلوكوز، وبين المتثابتات الدموية. وقد وجد ارتباط سلبي يعتد به إحصائياً بين مستوى هذا الإنزيم وبين الهيموغلوبين وحجم الكريات المكدسة وتعداد الكريات الحمر ووسطي هيموغلوبين الكريات ووسطي حجم الكريات. كما وجد ارتباط إيجابي يعتد به إحصائياً بين مستوى الإنزيم وبين تعداد الكريات البيض وتعداد الكريات الشبكية، بينما لم يوجد ارتباط يعتد إحصائياً به بين مستوى الإنزيم وبين وسطي التركيز الهيموغلوبين الكريات. إن الارتباط السالب بين مستوى الإنزيم وبين الهيموغلوبين ليوحي بأن المصابين بفقر الدم لديهم مستويات من هذا الإنزيم أعلى مما يوجد لدى الأفراد الأسوياء. كما أن الارتباط الموجب بين مستوى الإنزيم وبين تعداد كريات الدم البيض ليشير إلى أن الكريات البيض يمكن أن تلعب دوراً مهماً في تحديد مستوى الإنزيم النازع هدروجين فسفات – 6 – غلوكوز.

ABSTRACT The study involved 143 individuals and aimed to correlate normal glucose-6-phosphate dehydrogenase (G6PD) level with haematological parameters. A statistically significant negative correlation was found between G6PD level and haemoglobin, packed cell volume, red blood cell count, mean corpuscular haemoglobin and mean corpuscular volume. A statistically significant positive correlation was found between G6PD level and white blood cell count and reticulocyte count, but no significant correlation was found between G6PD level and mean corpuscular haemoglobin concentration. The negative correlation between G6PD level and haemoglobin suggests that anaemic people have higher G6PD levels than normal individuals. The positive correlation between G6PD level and white blood cell count indicates that white blood cells may play an important role in contributing to G6PD level.

Corrélation entre le niveau de glucose-6-phosphate-déshydrogénase (G-6-PD) et les paramètres hématologiques

RESUME Cette étude impliquait 143 personnes et visait à établir une corrélation entre le niveau normal de glucose-6-phosphate-déshydrogénase (G-6-PD) et les paramètres hématologiques. Une corrélation négative significative sur le plan statistique a été trouvée entre le niveau de G-6-PD et l'hémoglobine, l'hémocrite, la numération érythrocytaire, la teneur globulaire moyenne en hémoglobine et le volume globulaire moyen. Une corrélation positive significative sur le plan statistique a été trouvée entre le niveau de G-6-PD et le nombre des leucocytes et la numération réticulocytaire, mais aucune corrélation significative n'a été trouvée entre le niveau de G-6-PD et la concentration corpusculaire moyenne en hémoglobine. La corrélation négative entre le niveau de G-6-PD et l'hémoglobine laisse penser que les personnes anémiques ont des niveaux de G-6-PD plus élevés que les individus normaux. La corrélation positive entre le niveau de G-6-PD et le nombre des leucocytes indique que les leucocytes pourraient jouer un rôle important en contribuant au niveau de G-6-PD.

[1]*Department of Biochemistry, College of Medicine, University of Basra, Basra, Iraq.*
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Introduction

Glucose-6-phosphate dehydrogenase (G6PD) is a "house-keeping" enzyme vital for the life of every cell as it controls the first step in the pentose phosphate pathway converting glucose-6-phosphate to 6-phosphogluconolactone with the concomitant production of reduced nicotinamide adenine dinucloeotide phosphate (NADPH) [*1*]. In the red cells, this pathway is the only source of NADPH, which is vital to protect the cell and its haemoglobin (Hb) from oxidative damage [*1–3*].

The physiological significance of G6PD arises from the fact that the G6PD gene, located on the X-chromosome, is highly susceptible to mutations [*3,4*]. More than 400 G6PD variants have been described [*4,5*]. A large number of these variants have very low or no G6PD activity at all, the so-called G6PD deficiency which is the most common enzymopathy affecting red blood cells [*2,3*]. G6PD deficiency is the most common X-linked genetically determined enzyme abnormality affecting nearly all populations of the world, with high frequencies in areas of the world where malaria is, or was, endemic [*1,6–10*]. Such high frequency of G6PD deficiency in malarial regions is attributed to the powerful protection conferred by G6PD deficiency against infection with *Plasmodium falciparum* [*1,2,11,12*].

It has been found that the G6PD level is significantly higher in patients with anaemia and reticulocytosis [*13,14*]. In addition, patients suffering from infections with an increase in white blood cells (WBC) have a significantly increased G6PD level [*15*].

In Basra, considerable interest has been directed to the study of G6PD [*16–22*]. Our study aimed to correlate G6PD levels with haematological parameters.

Patients and methods

The study involved 143 patients between 3 years and 70 years of age, of whom 55 were males and 88 females. They were outpatients and were randomly selected by including the first of every five attendees. Those found to have G6PD deficiency were excluded from the study.

Haematological parameters—Hb, packed cell volume (PCV), red blood cell (RBC) count, white blood cell (WBC) count, reticulocyte count and red blood cell indices [mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC)]—were estimated manually in triplicate in accordance with the standard methods described by Dacie and Lewis [*23*]. G6PD screening was carried out by a fluorescent spot test method using an ultraviolet lamp (Griffin, United Kingdom) [*24*]. For the preparation of the haemolysate, each blood sample was centrifuged and the plasma and buffy coat were carefully removed. Then, the blood was washed three times with 0.9% sodium chloride solution and each time the buffy coat was carefully removed. The washed cells were lysed with a haemolysing solution [prepared from 0.05 mL 2-mercaptoethanol and 10 mL 0.27 M ethylene diamine tetraacetic acid (EDTA) to a volume of 1000 mL with water]. G6PD assay was performed in duplicate by the Beutler method using a UV-vis spectrophotometer (Perkin–Elmer, Germany) [*24*].

Correlation and linear regression analyses were carried out for G6PD level with each of the haematological parameters by the linear least-squares method [*25*]. A *P*-value of < 0.05 was considered to be statistically significant.

Results

We found a statistically significant negative correlation ($P < 0.01$) between G6PD level and Hb, PCV, RBC count, MCH and MCV (Table 1). A statistically significant positive correlation ($P < 0.01$) was found between G6PD level and WBC count and reticulocyte count, while no significant correlation ($P < 0.05$) was observed between G6PD level and MCHC (Table 1).

Discussion

The negative correlation found between G6PD activity and Hb, PCV and RBC count is in agreement with the observations of other researchers [*15,26*]. It indicates that those with anaemia have higher G6PD levels than non-anaemic individuals. El-Hazmi and Warsy [*15*] attributed such an increase in G6PD level in anaemic individuals to the following possible reasons: an increased reticulocyte count in anaemic patients; an increase in the number of young red cells in these patients; or a true increase in G6PD level. G6PD activity in reticulocytes and young red cells is distinctly higher than in old cells.

G6PD activity also showed a negative correlation with MCH and MCV. Such correlation could probably be due to the effects of anaemia where both MCH and MCV are below normal levels.

The positive correlation between G6PD level and reticulocyte count parallels the high reticulocyte count associated with anaemia. G6PD activity was positively correlated ($P < 0.01$) with WBC count, a finding also observed by El-Hazmi and Warsy [*15*]. Such correlation indicates that WBCs may play an important role in contributing to G6PD level. El-Hazmi and Warsy reported that in patients suffering from infections, with an increase in WBC count, G6PD activity was significantly raised and masked the deficiency state [*15*].

Therefore, careful removal of the buffy coat and adequate washing of the packed red cells is necessary to ensure a correct diagnosis of the enzyme deficiency. Re-evaluation at the enzyme level after correction for anaemia is also warranted.

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Table 1 **Regression analysis of glucose-6-phosphate dehydrogenase with haematological parameters**

Haematological parameter	*r*	*a*	*b*	*t*	*P*
Haemoglobin	–0.658	12.986	–0.435	–10.380	< 0.01
Packed cell volume	–0.690	13.610	–0.162	–11.319	< 0.01
Red blood cell count	–0.357	11.093	–0.762	–4.540	< 0.01
White blood cell count	0.382	5.780	0.326	4.908	< 0.01
Reticulocyte count	0.661	7.299	0.447	10.461	< 0.01
Mean corpuscular haemoglobin	–0.372	11.736	–0.143	–4.758	< 0.01
Mean corpuscular volume	–0.433	21.902	–0.061	–5.706	< 0.01
Mean corpuscular haemoglobin concentration	–0.103	10.981	–0.097	1.230	> 0.05

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Since haemoglobin disorders and glucose-6-phosphate dehydrogenase deficiency are common in most countries of the Region, developing well organized services for the prevention and control of these genetic disorders remains a priority. A wide range of health activities took place to improve the control of genetic disorders in the Region and to strengthen the existing screening programmes for these diseases.

Source: The work of WHO in the Eastern Mediterranean Region. Annual Report of the Regional Director. 1 January 31 December 1999. *Page 166.*