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RANA DAWOOD SALMAN AL-KAMIL, DAWOOD CH. AL-BAHADILY, HUSSEIN NASSER KHALAF AL-SALMAN

ASSESSMENT OF PUBLIC KNOWLEDGE AND AWARENESS REGARDING GLUCOSE-6-PHOSPHATE DEHYDROGENASE DEFICIENCY IN BASRAH CITY, IRAQ

Summary

Background. Glucose-6-Phosphate Dehydrogenase (G6PD) deficiency is a relatively common inherited enzyme disorder of red blood cells, especially in the Middle East. G6PD is an enzyme that prevents damage to red blood cells. G6PD deficiency might be associated with several different problems, including jaundice in the first 24 hours of life. The study aimed to assess the extent of awareness and knowledge of the community regarding G6PD deficiency. It was also aimed at determining the association between sociodemographic variables and the level of awareness of the general population of Basrah, Iraq. A survey that was descriptive and cross-sectional in nature was conducted between January and April 2022 across Basrah's four districts (city center, Al-Qurna). A structured questionnaire that was validated was sent through primary schools to families of students enrolled. The instrument has three sections: G6PD deficiency knowledge assessment, which consists of 10 items; symptom recognition, 7 items; and diet awareness, 9 items. Chi-square tests and descriptive statistics were used to analyze the data.

Results and conclusions. A total of 469 respondents completed the questionnaire (49 % male; 51 % female). Most of them scored well in general knowledge domains, as the overall level of knowledge was satisfactory. Nevertheless, glaring gaps emerged, as 76 % of respondents were not aware of the features of X-linked inheritance, 38 % could not identify the symptoms, and 43 % had misconceptions about dietary triggers. Males were less aware than female participants ($p < 0.05$). Their knowledge scores were positively related to an education level and marital status. In conclusion, Basrah population has satisfactory basic knowledge of G6PD deficiency, but shows significant gaps in knowledge regarding inheritance and clinical features. The need for better education, more screening exams and giving children with mental disorders attention in schools is highlighted by these findings.

Key words: G6PD deficiency, public awareness, genetic disorders, health education, community screening, hemolytic anemia

Dr R.D.S. Al-Kamil; prof. dr D.CH. Al-Bahadily ORCID: 0000-0002-2185-1002 Department of Clinical Laboratory Sciences, College of Pharmacy, University of Basrah, Iraq; prof. dr H. N.K. Al-Salman, Department of Pharmaceutical Chemistry, College of Pharmacy, University of Basrah, Iraq.
Contact e-mail: hussein.khalf@uobasrah.edu.iq; hsennaserh@yahoo.com

Introduction

Glucose-6-Phosphate Dehydrogenase **(**G6PD) deficiency is the most common genetic enzyme disorder of red blood cells. The global prevalence is more than 400 million [15]. G6PD deficiency is a condition that is almost always seen in males due to its location on the X chromosome. Women can be affected as well, but having a normal allele on one chromosome usually prevents symptoms. This condition can be highly regional, such as in the specific regions of Asia and Africa. G6PD is an important enzyme in a process that takes place in mitochondria of cells and produces NADPH. The purpose of NADPH is to help prevent reactive oxygen species from causing damage to cells. G6PD deficiency is almost always due to a mutation in the G6PD gene and can be inherited from parents. Mutations prevent the proper production of the G6PD enzyme, which leads to symptoms. Both parents have to pass down the mutated allele on their X chromosome for a male to have this condition since they only possess one X and one Y chromosome. Affected males will only pass the one affected allele on their X chromosome down to their daughters. Since daughters have X and Y chromosomes, they must also get a normal one from their father in order to show symptoms. This is why the condition is almost always seen in males. The condition mainly has symptoms associated with hemolytic anemia. People with G6PD deficiency can experience acute hemolytic episodes with symptoms like jaundice and hemoglobinuria. Antibiotics, antimalarials or foods (like legumes) trigger these severe illnesses, G6PD deficiency is present in areas like sub-Saharan Africa and some areas in Asia. This condition is commonly seen in certain areas around the world. The variation in the G6PD distribution pattern could be due to the selection pressure of malaria because the G6PD deficiency is protective against severe infection with Plasmodium falciparum. [2, 21]. G6PD deficiency is common and important. Still, in many places where it is common, awareness is low. Past studies, especially from the Middle East, illustrated that the majority of community were unaware about it being a genetic condition, its causes and the prevention of it [13]. When people are unaware of this, it causes hemolytic crises that could be prevented. It also results in a late diagnosis, especially in countries or regions that are blind to this issue. The deficiency of G6PD is a public health problem in Iraq, especially in southern governorates like Basrah. However, we are not aware of many researches carrying out a check to examine community awareness level or level of knowledge pattern, Basrah has a diverse population and varying economic circumstances. This makes it a suitable location for assessing public knowledge on the genetic disorder. In the Basrah region, G6PD deficiency is very common, and there are gaps in worldwide knowledge of the condition. The aim of this study was: to evaluate the current level of community knowledge and awareness regarding G6PD deficiency, assess the recognition of clinical symptoms and dietary triggers, identify sociodemographic

factors associated with knowledge levels and provide evidence-based recommendations for improving public health interventions.

Understanding the community's knowledge patterns will aid in the development of educational programs. In addition, it will inform policies on screening programs. In the end, one seeks to reduce the burden of preventable complications associated with G6PD deficiency.

Materials and methods

Study design and setting

This descriptive cross-sectional study was performed in Basrah Governorate of southern Iraq between January and April 2024. The research was conducted in four selected districts that are representative of different characteristics (socio-economic, geographic). They are: Basrah city center (urban), Al-Qurna (semi-urban), Al-Zubair (industrial), Al-Mdenah (residential-mixed).

Study population and sampling

People of Basrah aged 18 or older were the target population. A convenience sampling method was employed through primary schools and students were used to reach their families. The chosen methodology will enable broad community representation and will be cost-effective and feasible.

The minimum sample size for the study was 384 at a 5 percent margin of error with a 95 percent confidence level at 50 percent awareness (to maximize sample size). In order to compensate for projected non-responses and incomplete questionnaires, the target sample was increased to 500 people. Inclusion criteria included: people aged 18 and over, people who lived for at least a year in Basrah and voluntary consent to participate. The exclusion criteria included: those involved in healthcare and medicine, incomplete questionnaire responses and residents of Basrah who had been there for less than a year.

Data collection instrument

A questionnaire was prepared with the help of already existing studies. The officially validated questionnaire was first checked by experts and then released for pilot testing. From the pilot study, changes were always made in accordance with the pilot study results. According to three experts in hematology, public health and epidemiology, the questionnaire was content validated.

Questionnaire Structure:

- Section I: Sociodemographic profile (eight items).
- Section II consists of general knowledge items about G6PD deficiency.
- Section III identifies clinical symptoms (seven items).

- Section IV covers knowledge and triggers about food (nine items).

To check the clarity of the questionnaire, the time required to complete the questionnaire and the reliability of the questionnaire, a pilot test was done on 30 participants who were not from the study area. Some changes were made based on feedback to improve understanding.

Data collection procedure

After obtaining permission from the Directorate of Education in Basrah, questionnaires were distributed through selected primary schools. Students had been provided with questionnaires and explicit instructions to ensure completion by adult family members. Schools sent reminders with the follow-up to maximize response rates one week later.

Statistical analysis

SPSS version 28.0 was used to analyze data. Descriptive statistics were calculated for all variables. Continuous variables are expressed as mean ± standard deviation and categorical variables as frequency and percentage.

Knowledge was scored as follows: each correct answer received 1 point. It was possible to achieve total score for: General Knowledge (10), Symptoms (7) and Dietary Issues (9). Knowledge levels were classified as Poor, Fair and Good. Inferential statistics used chi-square tests for different variables, t-test for continuous variables and logistic regression to identify the predictors of good knowledge. A p-value of below 0.05 was considered statistically significant.

Ethical considerations

The Basrah Directorate of Education and the University of Basrah Research Ethics Committee approved the protocol of the study. All participants gave their consent and cannot be identified from the study. No personal identifiers were collected, ensuring anonymity.

Results

Response rate and participant characteristics

Of the 500 questionnaires distributed, 469 were complete with a 93.8 % response rate. The participants in the study consisted of 231 (49.3 %) males and 238 (50.7 %) females with an average age of 34.2 ± 12.8.

Table 1. Sociodemographic characteristics of study participants (N = 469)

Characteristic	Category	Frequency [%]
Gender	Male	231 (49.3)
	Female	238 (50.7)
Age Groups	< 20 years	165 (35.2)
	20 ÷ 50 years	271 (57.8)
	> 50 years	33 (7.0)
Education Level	Below high school	180 (38.4)
	Bachelor/Diploma	236 (50.3)
	Postgraduate	53 (11.3)
Marital Status	Single	94 (20.0)
	Married	375 (80.0)
Monthly Income (IQD)	< 1 million	258 (55.0)
	1 ÷ 2 million	161 (34.3)
	> 2 million	50 (10.7)
Consanguineous Marriage	Yes	211 (45.0)
	No	258 (55.0)
Family History of Genetic Disorders	Yes	154 (32.8)
	No	315 (67.2)

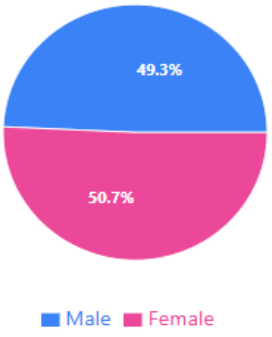


Figure 1. Gender distribution of study participants

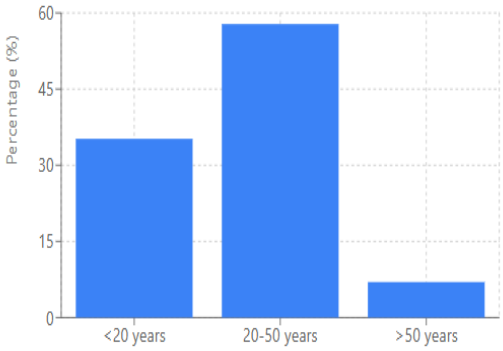
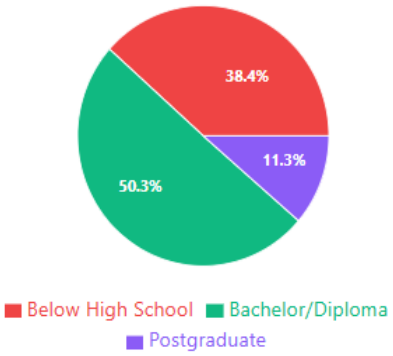


Figure 2. Age distribution of study participants



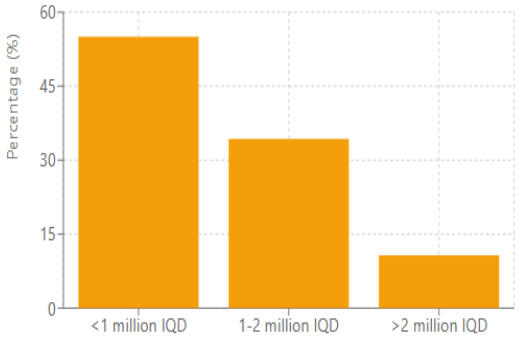


Figure 3. Educational level distribution Figure 4: Monthly family income distribution

General knowledge about G6PD deficiency

The general knowledge analysis showed varying levels of awareness regarding different aspects of the condition. While 82 % knew what G6PD deficiency was, their understanding of how it actually worked and how it was inherited was poor.

Table 2. General knowledge responses (N = 469)

Knowledge Item	Correct response n [%]	Incorrect/Do not know n [%]	*p*-value*
Heard of G6PD deficiency	386 (82.3)	83 (17.7)	-
Heard of "fava bean anemia"	422 (90.0)	47 (10.0)	-
G6PD deficiency is a type of anemia	398 (84.9)	71 (15.1)	0.032†
Inherited disorder	386 (82.3)	83 (17.7)	0.045†
X-linked inheritance (male predominance)	111 (23.7)	358 (76.3)	<0.001†
Both parents must be carriers	375 (80.0)	94 (20.0)	0.156
Fava beans can trigger hemolysis	384 (81.9)	85 (18.1)	0.028†
Should be included in premarital screening	272 (58.0)	197 (42.0)	0.089

Explanatory notes: *Chi-square test comparing correct vs incorrect responses †Statistically significant difference from random distribution

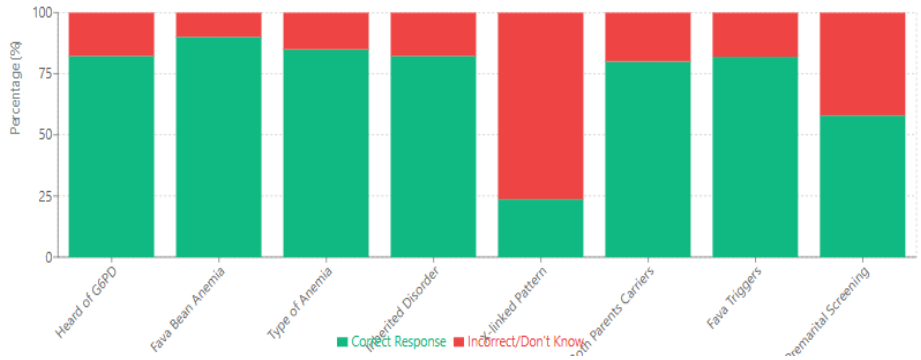


Figure 5. General knowledge about G6PD deficiency

Symptom recognition

According to the analysis of general knowledge responses, people seem to be knowledgeable over some of it. A total of 82 % of participants had heard of G6PD deficiency, but further questioning showed limited knowledge of the biochemical basis and inheritance pattern.

Table 3. Symptom Recognition (N = 469)

Symptom	Correct Recognition n [%]	Incorrect/Uncertain n [%]
Jaundice	358 (76.3)	111 (23.7)
Pallor	389 (82.9)	80 (17.1)
Gastrointestinal symptoms	312 (66.5)	157 (33.5)
Dizziness	308 (65.7)	161 (34.3)
Shortness of breath	228 (48.6)	241 (51.4)
Hepatosplenomegaly	214 (45.6)	255 (54.4)
Potential fatality	190 (40.5)	279 (59.5)

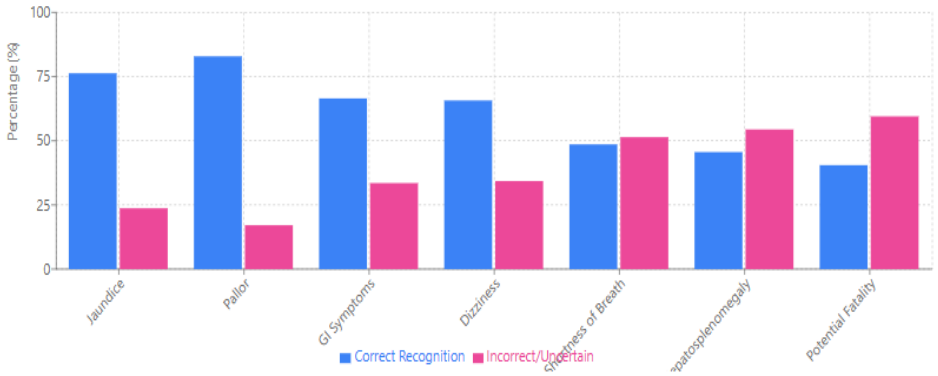


Figure 6. Clinical symptom recognition rates

Dietary awareness and misconceptions

Even though more than 90 % recalled that fava beans are a trigger food, many were mistaken about other foods. Many participants wrongly thought that foods permitted for G6PD people can cause hemolysis.

Table 4. Dietary knowledge and misconceptions (N = 469)

Food Item	Correctly identified as trigger n [%]	Misconception n [%]	Uncertain n [%]
Actual triggers:			
Fava beans	438 (93.4)	2 (0.4)	29 (6.2)
Non-triggers (Misconceptions):			
Lentils	65 (13.9)	370 (78.9)	34 (7.2)
Chickpeas	69 (14.7)	338 (72.1)	62 (13.2)
Kidney beans	55 (11.7)	311 (66.3)	103 (22.0)
Peanuts	40 (8.5)	408 (87.0)	21 (4.5)

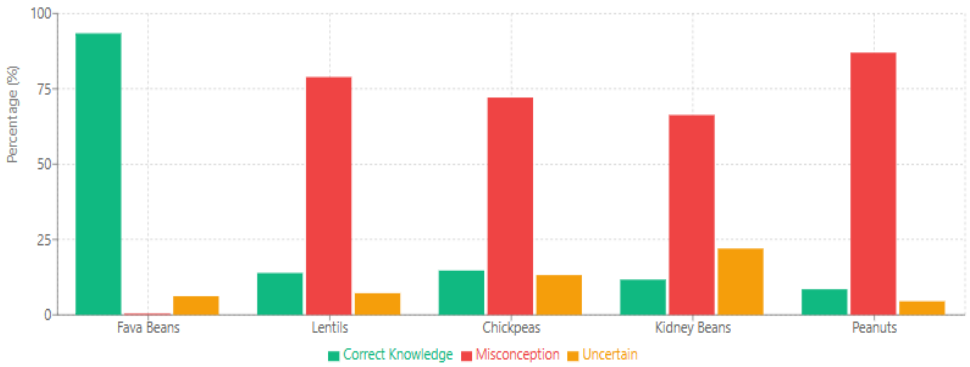


Figure 7. Dietary knowledge and common misconceptions

Factors associated with knowledge levels

Overall knowledge scores:

- Mean total knowledge score: 18.2 ± 4.6 (out of 26 possible points);
- Good knowledge (≥ 80 %): 312 participants (66.5 %);
- Fair knowledge (60 ÷ 79 %): 128 participants (27.3 %);
- Poor knowledge (< 60 %): 29 participants (6.2 %).

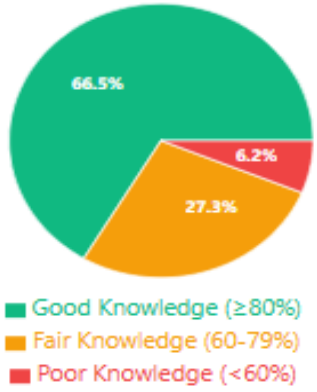


Figure 8. Overall knowledge level distribution

Table 5. Factors associated with good knowledge levels

Variable	Good Knowledge n(%)	Poor/Fair Knowledge n(%)	OR (95% CI)	*p*-value
Gender				
Female	172 (72.3)	66 (27.7)	1.67 (1.15÷2.42)	0.007*
Male	140 (60.6)	91 (39.4)	Reference	
Education Level				
Postgraduate	42 (79.2)	11 (20.8)	2.45 (1.21÷4.96)	0.013*
Bachelor/Diploma	168 (71.2)	68 (28.8)	1.58 (1.08÷2.31)	0.019*
Below high school	102 (56.7)	78 (43.3)	Reference	
Marital Status				
Married	265 (70.7)	110 (29.3)	1.89 (1.18÷3.03)	0.008*
Single	47 (50.0)	47 (50.0)	Reference	
Income Level				
> 2 million IQD	38 (76.0)	12 (24.0)	1.92 (0.96÷3.85)	0.065
1 ÷ 2 million IQD	112 (69.6)	49 (30.4)	1.39 (0.94÷2.05)	0.098
< 1 million IQD	162 (62.8)	96 (37.2)	Reference	

Explanatory notes: *Statistically significant ($p < 0.05$)

Figure 9. Knowledge levels by demographic characteristics

Multivariate analysis

Logistic regression analysis identified independent predictors of good knowledge:

- Female gender: OR 1.52 (95 % CI: 1.02 ÷ 2.27), $p = 0.041$
- Higher education: OR 1.83 (95 % CI: 1.34 ÷ 2.50), $p < 0.001$
- Married status: OR 1.47 (95 % CI: 0.89 ÷ 2.43), $p = 0.133$
- Family history of genetic disorders: OR 1.34 (95 % CI: 0.87 ÷ 2.06), $p = 0.179$

Discussion

Key findings

This research was the first one that managed to assess community knowledge on G6PD deficiency in Basrah, Iraq. As observed from the results, almost everyone is aware of the condition; however, there is a lack of knowledge of its most important aspects. A study which shows a good knowledge level of 66.5 % is comparable to reported findings from some other countries of the Middle East, where awareness level ranges from 30 ÷ 70 % [6, 16]. Although this is a positive result, there are important deficiencies that may have clinical consequences.

Knowledge gaps and clinical implication

The X-linked inheritance was not known to 76.3 % of the respondents, which refers to a lack of awareness. Due to the knowledge gap, genetic counseling and family planning might get misdirected. Since males are more frequently affected, and females can be carriers, the knowledge of inheritance patterns is important for risk assessment and prevention approaches [22]. It is clinically quite worrying to see the limited ability

to recognize clinical symptoms (59.5 % of those who claim not to have known it could result in death). Recognizing hemolytic episodes early is important for intervention in a timely manner to prevent associated complications like acute renal failure and kernicterus in neonates [19]. The results demonstrate that participants were quite aware about the potential trigger role of fava beans (93.4 %). However, the widespread misconception on other foods leads to unnecessary dietary restraint which can affect the quality of life and nutritional status. According to these results, there is a need for accurate evidence-based advice [7].

Demographic patterns

Gender Differences: due to the fact that women are traditionally the primary caregiver in the family and are more likely to access health-related information, it is likely that the difference in knowledge levels is observed. Other health awareness studies in the area show a similar trend [5]. There is a strong positive correlation between an educational level and knowledge scores (as indicated by 2.45 for postgraduate education). Support must be given for educational interventions targeting low formally educated populations [8].

Comparison with regional studies

The results are consistent with those observed in neighboring countries, while also showing some unique features. In the Saudi Arabia context, Al-Alabbas et al. [3] found awareness levels of 47 %, lower to our 66.5 %. A recent study conducted by Al-Abdi et al. [1] found that only 31.5 % of Omani mothers could name any of the triggering factors. In contrast, we found that 81.9 % name fava beans. According to the document by Al-Arrayed and Al-Hajeri [4], symptoms were better recognized in Bahrain than in this study. The health system, screening program and cultural laws differ from one country of origin to another.

Public health implications

Screening Program Development: the 58 % support for premarital screening suggests community acceptance of prevention strategies. However, the knowledge gaps identified indicate that screening programs should be accompanied by comprehensive educational components [9].

Healthcare provider training: the limited symptom recognition among the public highlights the need for enhanced healthcare provider education to ensure accurate diagnosis and appropriate patient education [23].

Educational interventions: Our findings support multi-level educational approaches: school-based programs targeting adolescents and families, community health worker training, mass media campaigns addressing specific misconceptions and integration into existing maternal and child health programs.

Study limitations

Several limitations should be acknowledged. Sampling Bias: the school-based sampling approach may have excluded less educated populations and those without school-age children, potentially overestimating overall knowledge levels. Social Desirability Bias: self-reported knowledge may be subject to overestimation, particularly on socially sensitive topics. Cross-sectional Design: the study design prevents the establishment of causal relationships between demographic factors and knowledge levels. Geographic Scope: results may not be generalizable to other Iraqi governorates with different demographic and cultural characteristics. Cultural Factors: the questionnaire, while validated, may not have fully captured culturally specific beliefs and practices related to genetic disorders.

Recommendations

Based on our findings, we propose the following evidence-based recommendations. Immediate actions that include the development of targeted educational materials addressing inheritance patterns and symptom recognition, training primary healthcare providers in G6PD deficiency counseling and the implementation of school-based health education programs. Medium-term goals, namely establishing comprehensive newborn screening programs, integrating G6PD education into premarital counseling services and developing community health worker training programs. As for long-term strategies, population-based screening and registry systems should be implemented, longitudinal studies to evaluate intervention effectiveness should be conducted and culturally appropriate educational resources should be developed in local languages.

Conclusions

1. People of Basrah have fair base knowledge regarding G6PD deficiency, however, they lack a lot of important knowledge about inheritance, symptoms and facts-based food advice. Understanding knowledge levels in a selected population helps in intervention planning.
2. The results suggest the creation of programs that operate at different educational levels to correct misconceptions in science and build on students' existing knowledge. Women and educated individuals can aid their local health campaigns due to their superior levels of knowledge.
3. Evaluating the impact of different communication strategies is essential to determine the most effective means of inducing behavioral change. Developing and evaluating biologically based interventions for disease management is also crucial as part of scientific research.

4. G6PD deficiency is the most prevalent deficiency in this region. Through systematic screening and evidence-based educational programs, the risks of preventable complications of the deficiency can be reduced significantly.

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OCENA WIEDZY I ŚWIADOMOŚCI SPOŁECZEŃSTWA DOTYCZĄCEJ NIEDOBORU DEHYDROGENAZY GLUKOZO-6-FOSFORANOWEJ W BASRAH W IRAKU

S t r e s z c z e n i e

Wprowadzenie. Niedobór dehydrogenazy glukozo-6-fosforanowej (G6PD) jest stosunkowo częstym dziedzicznym zaburzeniem enzymatycznym czerwonych krwinek, szczególnie na Bliskim Wschodzie. G6PD to enzym, który zapobiega uszkodzeniu czerwonych krwinek. Niedobór G6PD może być związany z wieloma różnymi problemami, w tym żółtaczką w pierwszych 24 godzinach życia. Celem badania była ocena stopnia świadomości i wiedzy społeczności na temat niedoboru G6PD. Celem badania było również określenie związku między zmiennymi socjodemograficznymi a poziomem świadomości ogółu populacji Basry w Iraku. Ankieta o charakterze opisowym i przekrojowym została przeprowadzona w okresie od stycznia do kwietnia 2022 r. w czterech dzielnicach Basry (centrum miasta, Al-Qurna). Ustrukturyzowany kwestionariusz, który został zweryfikowany, został rozesłany do szkół podstawowych do rodzin uczniów objętych badaniem. Narzędzie składa się z trzech sekcji: oceny wiedzy o niedoborach G6PD, składającej się z 10 pytań; rozpoznawania objawów, 7 pytań; oraz świadomości diety, 9 pytań. Do analizy danych wykorzystano testy chi-kwadrat i statystyki opisowe.

Wyniki i wnioski. Ankietę wypełniło łącznie 469 respondentów (49 % mężczyzn; 51 % kobiet). Większość z nich uzyskała dobre wyniki w zakresie wiedzy ogólnej, ponieważ ogólny poziom wiedzy był zadowalający. Niemniej jednak pojawiły się rażące luki, ponieważ 76 % respondentów nie było świadomych cech dziedziczenia sprzężonego z chromosomem X, 38 % nie potrafiło zidentyfikować objawów, a 43 % miało błędne przekonania na temat czynników wyzwalających dietę. Mężczyźni byli mniej świadomi niż kobiety uczestniczące w badaniu ($p < 0,05$). Ich wyniki wiedzy były dodatnio skorelowane z poziomem wykształcenia i stanem cywilnym. Podsumowując, populacja Basry posiada zadowalającą podstawową wiedzę na temat niedoboru G6PD, ale wykazuje istotne luki w wiedzy na temat dziedziczenia i objawów klinicznych. Wyniki te podkreślają potrzebę lepszej edukacji, większej liczby badań przesiewowych i poświęcania uwagi dzieciom z zaburzeniami psychicznymi w szkołach.

Słowa kluczowe: niedobór G6PD, świadomość społeczna, zaburzenia genetyczne, edukacja zdrowotna, badania przesiewowe w społeczności, niedokrwistość hemolityczna