Medical Science

pISSN 2321–7359; eISSN 2321–7367

Saudi mothers' knowledge, attitude and practice towards glucose 6 phosphate dehydrogenase deficiency: A cross sectional study

Taif Alqahtani, Amjad Alzahrani, Roudin Alhasawi, Rahaf Alqarehi, Lujain Alhashmi Alamer, Amna Alotiby*

To Cite:
Alqahtani T, Alzahrani A, Alhasawi R, Alqarehi R, Alamer LA, Alotiby A. Saudi mothers' knowledge, attitude and practice towards glucose 6 phosphate dehydrogenase deficiency: A cross sectional study. Medical Science 2022; 26:ms471e2533.
doi: https://doi.org/10.54905/disssi/v26i129/ms471e2533

Authors' Affiliation:
College of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

*Corresponding author
College of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia
Email address: aamogaty@uqu.edu.sa

Peer-Review History
Received: 18 October 2022
Reviewed & Revised: 20/October/2022 to 09/November/2022
Accepted: 11 November 2022
Published: 15 November 2022

Peer-review Method
External peer-review was done through double-blind method.

URL: https://www.discoveryjournals.org/medicalscience

ABSTRACT

Introduction: Glucose 6 phosphate dehydrogenase (G6PD) deficiency is an inheritable genetic condition resulting in the hemolysis of red blood cells after exposure to the risk factors. Its prevalence in Saudi Arabia is 4.76%. *Objectives:* The aim of this study was to evaluate the attitude and knowledge of Saudi mothers toward G6PD deficiency to guarantee the avoidance of triggering factors. *Method:* In this cross sectional study, 480 Saudi mothers from different cities across Saudi Arabia were recruited to assess their knowledge and attitude toward G6PD deficiency using an online questionnaire. *Results:* A total of 71% had not heard about G6PD deficiency and 291 (60.6%) had a poor knowledge level regarding G6PD deficiency anemia. Highly educated mothers had significantly (P=.007) higher scores than low educated mothers, mothers with children diagnosed with G6PD deficiency, females who had undergone a medical consultation before marriage and mothers who had genetic assessment before had recorded higher statistical significance (P=.001). As for risk factors, the most known among study mothers were eating fava beans (54.8%). Pallor was known for 56.7% of the study mothers regarding clinical presentation of G6PD deficiency anemia. 214 (44.6%) mothers agreed that G6PD deficiency anemia is a severe disease and 253 (52.7%) reported that consanguinity is a cause of G6PD deficiency anemia. *Conclusion:* About half the Saudi mothers had never heard of G6PD deficiency. Therefore, the knowledge levels were considered low. To ensure better prevention of the triggering factors, it is recommended to provide health education programs on G6PD deficiency.

Keywords: glucose 6 phosphate dehydrogenase deficiency, anemia, knowledge, awareness.

1. INTRODUCTION

Glucose 6 phosphate dehydrogenase (G6PD) deficiency is an inheritable, X linked genetic defect due to a mutation in the G6PD encoding gene (Cappellini and Fiorelli, 2008). Erythrocytes are subsequently more susceptible to oxidative stress (Ruwende and Hill, 1998). It is more prevalent in men, but female heterozygotes can also be at risk of hemolysis (Luzzatto et al., 2016). Worldwide, over 400 million people are affected by G6PD deficiency, Hence, it is considered the most popular enzymatic disorder (Albagshi et al., 2020; Cappellini and Fiorelli, 2008), frequently seen in the Mediterranean, African, Asian and Middle Eastern descent (World Health Organization et al., 1989). It is a relatively common disease in Saudi Arabia, with a prevalence of 4.76% (Alharbi and Khan, 2014). The eastern region has the highest rates reaching up to 26% in males and 9.9% in females (Albagshi et al., 2020; Nasserullah et al., 1998). Generally, G6PD deficient individuals are asymptomatic but can develop jaundice of the neonate and acute hemolysis if they consume fava beans, have certain infections or use some medications (Luzzatto et al., 2016). Neonatal jaundice is one of its most severe complications that can lead to kernicterus, death or spastic cerebral palsy (Gibbs et al., 1979; World Health Organization et al., 1989). A key component of treatment is avoiding oxidative stressors. Never the less, severe cases of anemia might necessitate a blood transfusion (Frank et al., 2005).

A study was done in Egypt by (Kasemy et al., 2020) to assess the prevalence of G6PD deficiency among neonates with jaundice and evaluate mothers' perception of G6PD and NNJ. Their study concluded that mothers' KAP toward G6PD deficiency was very low. The majority of participants referred to G6PD deficiency as Fava bean anemia since they were unaware of the term. Almost all of them thought that fava beans could trigger hemolysis due to G6PD deficiency. Nearly half of the mothers believed that drugs could trigger hemolysis. AlJabrawi's study in Hilla city in 2015 assessed maternal knowledge of neonatal G6PD deficiency and reported that the level of awareness was reasonably good (AlJabrawi et al., 2015).

However, there were still a few common misconceptions. Education and living in urban areas were associated with greater awareness among women. Furthermore, those who married into consanguineous marriages had more knowledge about the disease. A study conducted by (Alarrayed & AlHajeri, 2011) in Bahrain to evaluate the awareness of the public regarding G6PD deficiency showed a good level of knowledge of G6PD deficiency. Some of the participants had some confusion about the inheritance pattern. Women had a significant higher awareness level about the disease compared to men. Married persons were more knowledgeable than non married. A study by Almuhaini et al., (2018) measured the degree of awareness and knowledge of G6PD deficiency in 86 randomly chosen respondents in Riyadh city. It concluded that the Saudi community showed a low level of knowledge regarding the disease, whether it is a blood disorder, as well as specific aspects such as its inheritance pattern, symptoms and that exposure to some factors can lead to hemolysis.

A recent study conducted in the Jazan region to evaluate the public knowledge and awareness toward G6PD deficiency by Hassan A Hamali discovered good knowledge regarding the disorder itself but none regarding the inheritance mode (Hamali et al., 2022). In Saudi Arabia, the incidence of G6PD deficiency has been the subject of numerous investigations. Although G6PD deficiency is highly prevalent in Saudi Arabia, two studies were carried out to evaluate the general public's awareness and practice about G6PD deficiency. One of the studies was carried out in Riyadh and the other in the Jazan region (Almuhaini et al., 2018; Hamali et al., 2022). To our knowledge, no studies have measured the level of awareness among Saudi mothers about the disease. Furthermore, there was no Kingdom wide data available on the KAP towards G6PD deficiency. Therefore, the present study aimed to assess Saudi mothers' level of knowledge and attitude toward G6PD deficiency. Having a better insight in to mothers' KAP can assist in developing educational interventions about G6PD to correct misconceptions and ensure that triggering factors are avoided.

2. MATERIALS AND METHODS

The current cross sectional descriptive study was conducted in Saudi Arabia from July 1, 2022, to August 16, 2022. An initial pilot research with 30 participants was carried out to evaluate the reliability of the questionnaire's Arabic version. The data was obtained via an online Google Forms questionnaire and was electronically distributed randomly among Saudi mothers. The inclusion criterion included Saudi mothers aged 18 and older who had a live birth before this study, while the exclusion criterion included healthcare workers' mothers and mothers with a medical education background.

Based on the Saudi general authority of statistics, the latest estimated population of females aged 18 and above is approximately 9,700,000, including non Saudi females (General Authority for Statistics et al., 2022). We calculated the sample size using the Open Epi website (Sullivan et al., 2009) with a confidence level of 95% and a 5% margin of error. The calculated sample size was 385 participants. The recruitment of participants was conducted by convenience sampling and the questionnaire link was distributed among the population through social media and Emails. The study's questions were closed ended that was modified and adopted

from a previously published study. The questionnaire included four parts which are: (A) socio-demographic data, (B) knowledge of G6PD deficiency, (C) attitude towards G6PD deficiency and (D) practice regarding G6PD deficiency.

Data analysis

The data were extracted, revised and entered in to Social Sciences Statistical Package version 21 (SPSS: An IBM Company). Data were statistically analyzed using two tailed with an alpha level of 0.05, considering significance if P-value is equivalent or less than 0.05. Overall knowledge level regarding G6PD deficiency was assessed by summing up discrete scores for different correct knowledge items. The knowledge score was categorized as: a poor level if the mothers' score was 60% or less from the overall score and a good level of knowledge was considered if the mothers' score was 60% or more of the overall score. Descriptive analysis was done by prescribing frequency distribution and percentage for study variables, including mothers' personal data, educational level and if they had a child with G6PDD deficiency anemia. Also, knowledge regarding G6PD deficiency, risk factors and, clinical presentations was also tabulated and overall knowledge was graphed. Frequency tables for mothers' attitudes and practices were constructed. Cross tabulation for showing the distribution of participants' overall knowledge level by their personal data and practice was carried out with Pearson chi square test for significance and exact probability test if there were small frequency distributions.

3. RESULTS

A total of 480 Saudi mothers fulfilling the inclusion criteria completed the study questionnaire. Mothers' ages ranged from 18 to more than 50 years, the mean age was 42.1 ± 10.8 years. A total of 409 (85.2%) mothers were married (not separated/widowed). As for education level, 322 (67.1%) mothers had a university level of education or above, while 124 (25.8%) had a secondary level of education. A total of 55 (11.5%) mothers reported that they had a child with glucose 6 phosphate dehydrogenase deficiency (Table 1).

Table 1 Personal data of sampled Saudi mothers, Saudi Arabia

Personal data	No	%
Region		
Central Region	109	22.7%
Northern Region	107	22.3%
Eastern Region	152	31.7%
Western Region	112	23.3%
Age in years		
18-30	129	26.9%
31-40	127	26.5%
41-50	166	34.6%
> 50	58	12.1%
Marital status		
Married	409	85.2%
Divorced / widow	71	14.8%
Educational level		
Below secondary	34	7.1%
Secondary / diploma	124	25.8%
University / above	322	67.1%
Do you have a child with glucose 6 phosphate dehydrogenase deficiency?		
Yes	55	11.5%
No	425	88.5%

Generally, 29% of the study mothers had heard about G6PD deficiency, 66.9% of them knew that it was a blood disease and 58.1% reported that G6PD deficiency (hemolytic anemia) is a genetic disease. Also, 37.7% said that the parents must be carriers of G6PD, or hemolytic anemia, to have an affected child and 24.4% know that Inheritance of G6PD is related to the sex of the child. As

for risk factors, the most known among study mothers were eating fava beans (54.8%), followed by Having a family history of G6PD (43.3%), some medications (33.8%) and mother related factors (19.2%). With regard to the clinical presentation, pallor was known for 56.7% of the study mothers, followed by dizziness and light headedness (46.7%), shortness of breath (41%) and jaundice (35.8%). In addition, 29 (6%) mothers answered no to nausea, vomiting, loss of appetite and diarrhea being one of the clinical features of G6PD (Table 2).

Table 2 Saudi mothers' knowledge regarding glucose 6 phosphate dehydrogenase deficiency

Domain	Items		No	%
General Awareness	Have you ever heard of glucose 6 phosphate dehydrogenase deficiencies (G6PD)?	Yes	139	29.0%
		No	341	71.0%
	Have you ever heard of bean anemia?	Yes	341	71.0%
		No	139	29.0%
	Glucose 6 phosphate dehydrogenase deficiency is a blood disease.	Yes	321	66.9%
		No	23	4.8%
		Don't know	136	28.3%
	Glucose 6 phosphate dehydrogenase deficiency (hemolytic anemia) is a genetic disease.	Yes	279	58.1%
		No	25	5.2%
		Don't know	176	36.7%
	The parents must be carriers of G6PD or hemolytic anemia to have an affected child	Yes	181	37.7%
		No	78	16.3%
		Don't know	221	46.0%
	Inheritance of G6PD is related to the sex of the child	Yes	117	24.4%
		No	127	26.5%
		Don't know	236	49.2%
Risk Factors	Do you know if you have risk factors for having a baby with G6PD?	Yes	92	19.2%
		No	103	21.5%
		Don't know	285	59.4%
	Having a family history of G6PD is a condition for having the same disease	Yes	208	43.3%
		No	60	12.5%
		Don't know	212	44.2%
	Can some medications cause G6PD Deficiency anemia?	Yes	162	33.8%
		No	36	7.5%
		Don't know	282	58.8%
	Can eat fava beans cause G6PD Deficiency anemia?	Yes	263	54.8%
		No	34	7.1%
		Don't know	183	38.1%
Clinical presentation	Is pallor a symptom of G6PD Deficiency anemia?	Yes	272	56.7%
		No	18	3.8%
		Don't know	190	39.6%
	Are Loss of Appetite, Nausea, Diarrhea, and Vomiting complaints of anemia of G6PD Deficiency	Yes	186	38.8%
		No	29	6.0%
		Don't know	265	55.2%
	Are dizziness and lightheadedness a symptom of G6PD deficiency anemia?	Yes	224	46.7%
		No	24	5.0%
		Don't know	232	48.3%
	Is shortness of breath a symptom of G6PD deficiency anemia?	Yes	197	41.0%
		No	36	7.5%

		Don't know	247	51.5%
	Is G6PD deficiency anemia a cause of jaundice?	Yes	172	35.8%
		No	45	9.4%
		Don't know	263	54.8%

Figure 1 illustrates the overall Saudi mother's knowledge level regarding anemia of G6PD deficiency. A total of 189 (39.4%) mothers had good knowledge levels regarding G6PD deficiency anemia, while 291 (60.6%) had poor knowledge levels.

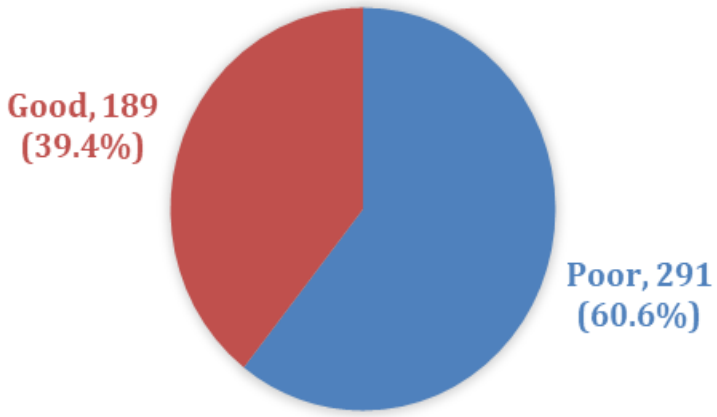

Figure 1 Overall Saudi mother's knowledge level regarding G6PD deficiency anemia, Saudi Arabia.

Exact of 214 (44.6%) mothers agreed that the anemia of G6PD deficiency is a serious problem, 253 (52.7%) reported that consanguineous marriage is a cause of G6PD deficiency anemia, 237 (49.4%) said that child with G6PD deficiency be monitored for life, but 145 (30.2%) disagreed for that pregnancy contraindicated if in the family there is a child affected by the anemia of G6PD deficiency (Table 3).

Table 3 Saudi mothers' attitude towards glucose 6 phosphate dehydrogenase deficiency

Attitude items	Yes		No		Not sure	
	No	%	No	%	No	%
Is G6PD deficiency anemia a serious problem?	214	44.6%	84	17.5%	182	37.9%
Is consanguineous marriage a cause of G6PD deficiency anemia?	253	52.7%	48	10.0%	179	37.3%
If in the family there is a child affected by anemia of G6PD deficiency; is pregnancy contraindicated?	77	16.0%	145	30.2%	258	53.8%
Should a child affected by G6PD deficiency be monitored for life?	237	49.4%	51	10.6%	192	40.0%

A total of 192 (40%) mothers reported that they had undergone a medical consultation before marriage, 339 (70.6%) asked for a medical consultation after birth to be sure, but only 70 (14.6%) had a genetic assessment before (Table 4).

Table 4 Saudi mothers' practice regarding glucose 6 phosphate dehydrogenase deficiency

Practice items	Yes		No		Don't know	
	No	%	No	%	No	%
Did you undergo a medical consultation before marriage?	192	40.0%	288	60.0%	0	0.0%
Have you had a genetic assessment before?	70	14.6%	356	74.2%	54	11.3%
Do you ask for a medical consultation after birth to be sure?	339	70.6%	141	29.4%	0	0.0%

Approximately 42.2% of highly educated mothers had good knowledge levels regarding the disease compared to 14.7% of a low level of educational mothers with recorded statistical significance (P=.007). Also, 78.2% of mothers with a child diagnosed with glucose 6 phosphate dehydrogenase deficiency had good knowledge levels versus 34.4% of others who did not have (P=.001) (Table 5).

Table 5 Distribution of Saudi mothers' knowledge regarding G6PD deficiency anemia by their personal data

Factors	Awareness level				p-value
	Poor		Good		
	No	%	No	%	
Region					
Central Region	74	67.9%	35	32.1%	.001*$
Northern Region	51	47.7%	56	52.3%	
Eastern Region	78	51.3%	74	48.7%	
Western Region	88	78.6%	24	21.4%	
Age in years					
18-30	73	56.6%	56	43.4%	.318
31-40	75	59.1%	52	40.9%	
41-50	102	61.4%	64	38.6%	
> 50	41	70.7%	17	29.3%	
Educational level					
Below secondary	29	85.3%	5	14.7%	.007*$
Secondary / diploma	76	61.3%	48	38.7%	
University / above	186	57.8%	136	42.2%	
Marital status					
Married	249	60.9%	160	39.1%	.784
Divorced / widow	42	59.2%	29	40.8%	
Do you have a child with glucose 6 phosphate dehydrogenase deficiency?					.001*
Yes	12	21.8%	43	78.2%	
No	279	65.6%	146	34.4%	

*P: Pearson X2 test :$Exact probability test * P < 0.05 (significant)*

A total of 51.3% of females with good knowledge underwent a medical consultation before marriage in comparison to 32.6% of others with poor knowledge levels (P=.001). Additionally, 18.5% of mothers with good knowledge of the disease had a genetic assessment before versus 12% of mothers who had poor knowledge (P=.001), (Table 6).

Table 6 Relation between Saudi mother's knowledge regarding G6PD deficiency anemia and their practice

Practice items	Awareness level				p-value
	Poor		Good		
	No	%	No	%	
Did you undergo a medical consultation before marriage?					.001*
Yes	95	32.6%	97	51.3%	
No	196	67.4%	92	48.7%	
Have you had a genetic assessment before?					.001*$
Yes	35	12.0%	35	18.5%	
No	209	71.8%	147	77.8%	
Don't know	47	16.2%	7	3.7%	
Do you ask for a medical consultation after birth to be sure?					.123
Yes	198	68.0%	141	74.6%	
No	93	32.0%	48	25.4%	

*P: Pearson X2 test $: Exact probability test * P < 0.05 (significant)*

4. DISCUSSION

Generally, the mothers participating in this study had poor knowledge levels regarding G6PD deficiency, with a score level of 39.4%, similar to what was observed in a study that took place in Riyadh by (Almuhaini et al., 2018), but in contrast to (Alarrayed and Al Hajeri, 2011) in which the knowledge level was good. However, an acceptable knowledge level was reported by (Hamali et al., 2022). In addition, in Saudi Arabia, when comparing the five regions, the mothers of the northern region showed the best knowledge level (52%), whereas the Western region's mothers showed the minor knowledge level (21.4%).

The majority of the mothers (71%) did not hear of the term G6PD deficiency, while only 29% of them did not know the term fava bean anemia; this can be attributed to the fact that the disease is most commonly known in Saudi Arabia as fava bean anemia. This also was observed in a study conducted in the region of Jazan by (Hamali et al., 2022) and in Egypt by (Kasemy et al., 2020) but in contrast to a similar study done in Bahrain by (Alarrayed and Al Hajeri, 2011) in which almost all of the respondents knew the disease by its scientific name. Although recognizing G6PD deficiency as a blood disease and a genetic disease was evident by 66.9% and 58.1% of the mothers, respectively, the same awareness about the mechanism of inherence was significantly poor; this gap of knowledge was in agreement with (Hamali et al., 2022) and (Alarrayed and AlHajeri, 2011).

G6PD deficiency is an X linked hereditary disease that only affects males who have a positive family history or consanguineous parents. According to (Kasemy et al., 2020), consanguinity and family history of G6PD deficiency was reported among 21.1% and 29.6% of their sample population, respectively. Likewise, among the 510 infants and children who were participants in the study done by (Julien Didier Adedemy et al., 2015), 20.4% were born from consanguineous parents. In the current study, approximately half of the participants mothers denied knowing these risk factors corresponding to (Hamali et al., 2022) findings, as 80% of the participants were unaware of their risk factors. However, recognizing the ingestion of fava beans as a trigger for the attacks was observed in most of the mothers (54.8%) and a similar percentage (57.8%) was reported in (Hamali et al., 2022) study. Similarly, 87% of the participants had a satisfactory awareness level of the possibility that beans might precipitate hemolysis in an individual with G6PD deficiency, according to (Al-Suwaid et al., 2015). Likewise, exposure to an oxidative medication can induce acute hemolysis that was unfortunately familiar to only one third of the participants, this percentage is slightly raised to 43% 40% according to (Alarrayed and AlHajeri, 2011) and (Kasemy et al., 2020), respectively.

In terms of the signs and symptoms, Saudi mothers showed a moderate level of awareness. Pallor was the most widely recognized symptom, then dizziness, shortness of breath and jaundice. Only a minority denied that nausea, vomiting, appetite loss, and diarrhea were symptoms of G6PD. These findings are in accordance with (Hamali et al., 2022). Furthermore, they are consistent with (Alarrayed and AlHajeri, 2011) study based on the order of signs and symptoms, although their population had a higher level of awareness as evidenced by more significant percentages of people who recognized each sign and symptom. Contrary to (Almuhaini et al., 2018) and (Kasemy et al., 2020) in which, the majority poorly recognized pallor and other signs and symptoms.

Despite the fact that hyperbilirubinemia caused by G6PD deficiency increases the risk of kernicterus and death in specific populations (Frank et al., 2005), only 44.6% of mothers thought it is a serious problem and around half of them had good attitudes towards if the child must be monitored for life for other clinical presentations such as acute and chronic hemolytic anemia.

Saudi mothers' practice was satisfactory for after birth medical consultation and moderate for premarital medical counseling. Nevertheless, only a minority had a genetic assessment. The results were inconsistent with the (Kasemy et al., 2020) study, where all participants had premarital counseling, a small percentage had a genetic assessment, but none of them sought medical advice after birth. Significant results were observed in the relation between Saudi mothers' knowledge regarding G6PD deficiency anemia and their practice. Over half of the knowledgeable mothers had premarital medical consultations. Furthermore, 18.5% of knowledgeable mothers about the disease had undergone a genetic assessment as opposed to 12% of whom the knowledge was recorded as poor.

5. CONCLUSION

The knowledge levels of Saudi mothers were low, as demonstrated by the fact that around half the participating Saudi mothers had never heard of G6PD deficiency. Increased maternal education, maternal diagnosis of a child with glucose 6 phosphate dehydrogenase deficiency, female medical consultations prior to marriage and maternal genetic assessments all significantly improved knowledge. About half of the participants had good attitudes towards the seriousness and the relation of consanguinity to glucose 6 phosphate dehydrogenase deficiency. It is recommended to offer comprehensive health education programs on G6PD deficiency to provide more accurate and earlier detection, appropriate timing of treatment and better prevention of the triggering causes.

Acknowledgment

Authors would like to thank the participants who contributed to this study.

Author Contributions

Alqahtan T, Alzahrani A, Alhasawi R, Alqarehi R, Alhashmi Alamer L and Alotiby A, have been involved in the study conception, methodology design, data interpretation, drafting of the article, revising it critically and approved the final version for publication.

Ethical approval

Ethical approval was obtained from the Committee of Biomedical Ethics of Umm Al-Qura University (Approval number: HAPO-02-K-012-2022-04-1063)

Informed consent

An online informed consent form was posted on the first page of the questionnaire; no participants were enrolled in the study unless they agreed to the study consent before answering the questionnaire. All answers were taken with anonymity and participation was voluntary.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

Data that support the findings of this study are embedded within the manuscript.

REFERENCES AND NOTES

1. Alarrayed S, Al-Hajeri A. Public Awareness of Glucose 6 Phosphate Dehydrogenase (G6PD) Deficiency. Bahrain Medical Bull 2011; 33:147-149
2. Albagshi MH, Alomran S, Sloma S, Albagshi M, Alsuweel A, Al-Khalaf H. Prevalence of Glucose 6 Phosphate Dehydrogenase Deficiency Among Children in Eastern Saudi Arabia. Cureus 2020; 12: e11235. doi: 10.7759/cureus .11235
3. Alharbi KK, Khan IA. Prevalence of glucose 6 phosphate dehydrogenase deficiency and the role of the A− variant in a

Saudi population. J Int Med Res 2014; 42:1161–7. doi: 10.1177/0300060514531923

4. AlJabrawi SF. Extent of Knowledge of Mothers of Neonates with G6PD Deficiency in Hilla City. J Babylon Univ: J App Pure Sci 2015; 23:1542-1550
5. Almuhaini MS, Alruzayhi MK, Alwassel AI. Public Awareness of Glucose 6 Phosphate Dehydrogenase (G6PD) Deficiency Causes and Prevalence Factors. J Middle East North Afr Sci 2018; 4:45–7. doi: 10.12816/0045066
6. Al-Suwaid H, Darwish M, Sabra A. Knowledge and misconceptions about sickle cell anemia and glucose 6 phosphate dehydrogenase deficiency among adult sickle cell anemia patients in al Qatif Area (eastern KSA). Int J Med Public Health 2015; 5:86. doi: 10.4103/2230-8598.151269
7. Cappellini MD, Fiorelli G. Glucose 6 phosphate dehydrogenase deficiency. Lancet 2008; 371:64–74. doi: 10.1016/S0140-6736(08)60073-2
8. Frank JE. Diagnosis and management of G6PD deficiency. Am Fam Physician 2005; 72:1277-1282.
9. General Authority for Statistics. Saudi Arabia (KSA) Population Statistics. Saudi Arabia Government 2022; https://www.stats.gov.sa/en/43. (Accessed March 15, 2022).
10. Gibbs WN, Gray R, Lowry M. Glucose 6 Phosphate Dehydrogenase Deficiency and Neonatal Jaundice in Jamaica. Br J Haematol 1979; 43:263–74. doi: 10.1111/j.1365-2141.1979.tb03750.x
11. Hamali HA, Muasbil AA, Otaif TH, Qahtani MK, Saboor M, Dobie G, Madkhali AM, Akhter MS, Chandika RM, Mobarki AA. Public knowledge and awareness toward glucose 6 phosphate dehydrogenase deficiency in Jazan region. King Khalid Univ J Health Sci 2022; 7:52. doi: 10.4103/kkujhs.kkujhs_11_22
12. Julien Didier Adedemy, Moutawakilou Gomina, Joseph Agossou, Alphonse Noudamadjo, Adedemy JD, Gomina M, Agossou J, Noudamadjo A, Yerima EM, d'Almeida M, Adeothy-Koumakpaï S, Akpona SA. Prevalence of glucose 6 phosphate dehydrogenase deficiency among infants and Children of Parakou, Benin Curr Pediatr Res 2015; 19:58-65
13. Kasemy ZA, Bahbah WA, el Hefnawy SM, Alkalash SH. Prevalence of and mothers' knowledge, attitude and practice towards glucose 6 phosphate dehydrogenase deficiency among neonates with jaundice: A cross sectional study. BMJ Open 2020; 10:e034079–e034079. doi: 10.1136/bmjopen-2019-034079
14. Luzzatto L, Nannelli C, Notaro R. Glucose 6 Phosphate Dehydrogenase Deficiency. Hematol Oncol Clin North Am 2016; 30:373–93. doi: 10.1016/j.hoc.2015.11.006
15. Nasserullah Z, al Jame A, Abu Srair H, al Qatari G, al Naim S, al Aqib A, Mokhtar M. Neonatal Screening for Sickle Cell Disease, Glucose 6 Phosphate Dehydrogenase Deficiency and α-Thalassemia in Qatif and Al Hasa Ann Saudi Med 1998; 18:289–92. doi: 10.5144/0256-4947.1998.289
16. Ruwende C, Hill A. Glucose 6 phosphate dehydrogenase deficiency and malaria. J Mol Med 1998; 76:581–8. doi: 10.1007/s001090050253
17. Sullivan KM, Dean A, Soe MM. Open Epi: A web based epidemiologic and statistical calculator for public health. Public Health Rep 2009; 124:471–4. doi: 10.1177/003335490912400320
18. World Health Organization. Glucose 6 phosphate dehydrogenase deficiency. WHO Working Group Bull World Health Organ 1989; 67:601–11.