Assessment of Premarital Screening for Prospective Couples in Aseer Region, Saudi Arabia, 2021

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Abstract

Aim of Study: to assess the prevalence of genetic and infectious diseases that could be identified through premarital screening in Aseer Region during 2021.

Methods: Following a retrospective research design, this study included data of all prospective couples who underwent premarital examination in Aseer Region, Saudi Arabia, during 2021 (N=25,023). The researchers retrieved data of all prospective couples registered during 2021 through the Health Services Platform "Seha" for Aseer. Retrieved data included number of marriage proposals, lab results for inherited hemoglobinopathies, and chronic diseases, i.e., hepatitis B, hepatitis C, and human immunodeficiency virus, (HIV/AIDS). A total of 128 patients with hepatitis B were identified (100, 78.1% were males), while 13 hepatitis C patients were identified (11, 84.6% were males), in addition to 9 HIV/AIDS patients, all of whom were males.

Conclusions: Sickle cell disease and hepatitis B are commonly identified by premarital examination in Aseer Region. Males are more frequently affected than females. Health education regarding the negative impact of consanguinity is highly needed. Vaccination against hepatitis B should be enforced. Prospective couples whose offspring is at risk of hereditary diseases should be strongly convinced to comply with marriage cancellations.

Key words: Premarital screening, Sickle cell disease, β-thalassemia, Hepatitis B, Hepatitis C, HIV/AIDS, Saudi Arabia.

Introduction

Autosomal recessive disorders, such as sickle cell disease, beta thalassemia, and other hemoglobinopathies are the most common genetic blood disorders in the Middle Eastern countries (1). The incidence of children born with sickle cell disease is expected to increase globally by 30% by 2050 (2). Available evidence suggests that congenital and genetic disorders are responsible for a large portion of mortality and handicap leading to poor quality of life of younger adults in this region. The incidence of hereditary blood disorders is intertwined with social, cultural, and religious practices in Middle Eastern countries, which makes the management of the disorders more complicated. This creates a huge burden on the individuals and families and the health care systems in these countries (3).

Premarital medical examination has been recommended as an effective measure for the prevention of several diseases. It is a consultation offered to individuals planning to marry. It involves history taking, clinical examination, and laboratory investigations to screen for inherited and communicable diseases (4). It refers to policies that make certain medical examinations a necessary condition for marriage, especially those in which diseases are endemic, for various legal and cultural reasons, and other educational and cost-effectiveness factors (5-6).

Premarital screening and genetic counselling programs have been established and implemented in eight Middle Eastern countries. This program offers premarital genetic counseling to couples at risk for hemoglobinopathy disorders and is considered as a mandatory step before receiving a marriage license (7).

Currently, premarital screening in Saudi Arabia includes laboratory testing and medical consultation sessions for common genetic blood disorders (i.e., sickle cell disease and thalassemia) and infectious diseases (i.e., hepatitis B, hepatitis C, and HIV/AIDS). Screening takes place at over 131 healthcare centers across the Kingdom, and couples planning to marry must attend at least three months prior to the marriage date. Screening aims to determine the odds of transmitting these diseases to the other partner or children and to provide partners with options to plan for a healthy family (4).

Premarital screening and genetic counseling programs can identify and modify the health risk factors known to impact genetic disorders. Premarital screening could be the most important way to prevent the several genetic blood disorders and many medical, psychological, and social marital problems (8). Premarital screening and genetic counseling programs have been declared mandatory in several Middle Eastern countries, including the Kingdom of Saudi Arabia. They are offered free of cost to reduce the at-risk marriages and the prevalence of genetic disorders (7).

A review conducted on the effectiveness of premarital screening and genetic counseling programs for beta thalassemia in Middle Eastern countries has revealed that a cancelation rate of 65% of at-risk marriage could not be achieved except in Iran, Turkey, and Iraq (7).

In the southern region of Saudi Arabia, hemoglobin abnormalities are still prevalent. In addition, prevalence of hemoglobin variants, including sickle cell and thalassemia, was higher in the younger population born after the premarital screening than in older subjects (9).

It is to be noted that in the Arab region, a greater proportion of people may prefer consanguineous marriages (10). Moreover, abortion is considered illegal, which necessitates urgent efforts to prevent the marriage of the disease-carrier couples (11). Therefore, premarital screening can help the couple prepare themselves for marriage with proper premarital counseling giving them a better chance for a stable and satisfying marriage.

Al-Mendalawi (12) argued that consanguineous marriage is a noticeable phenomenon in Saudi Arabia that tremendously contributes to the relatively high prevalence of various genetic diseases, particularly hemoglobinopathies. The control of consanguineous marriage remains a challenge if these diseases are to be successfully contained. It has often been proposed that consanguineous marriage should be strongly discouraged on the basis of medical background to prevent various genetic diseases. However, several expert groups have pointed out that this proposal is inconsistent with the ethical principles of genetic counseling, overlooks the social importance of consanguineous marriage, and is ineffective. Instead, they have suggested that the custom increases the possibilities for effective genetic counseling, and have recommended a concerted effort to identify families at increased risk, and to provide them with risk information and carrier testing when feasible. Therefore, it is anticipated that implementation of premarital screening and genetic counseling programs could provide adequate preventive measures at primary, secondary, and tertiary levels and effectively contain these genetic diseases in a highly consanguineous population, like Saudi Arabia.

Therefore, it is important to assess the data and yield of premarital screening recently conducted in Aseer region, in the southeastern area of Saudi Arabia. This is crucial in developing strategies to create awareness and build positive attitudes toward premarital screening.

Aim of study

The present study aimed to assess the prevalence of genetic and infectious diseases that could be identified through premarital screening in Aseer Region during 2021.

Methodology

Following a retrospective research design, this study included data of all prospective couples who underwent premarital examination in Aseer Region, Saudi Arabia, during 2021, and who registered at the Premarital Screening and Genetic Counseling (PMSGC) program. The researchers retrieved data of all prospective couples registered through the Health Services Platform "Seha" for Aseer Region during 2021.

Retrieved data included number of marriage proposals, lab results for inherited hemoglobinopathies, i.e. sickle cell disease and β-thalassemia, in addition to certain chronic diseases, i.e. hepatitis B, hepatitis C, and human immunodeficiency virus, (HIV/AIDS). No personal identification data (name, national ID or mobile phone number) were included.

The ethical approval for conducting the present study was obtained from the Institutional Research Board at the General Directorate of Health Affairs in Aseer Region, Saudi Arabia. Collected data were analyzed using the Statistical Package for Social Sciences (IBM, SPSS, version 28).

Results

Table 1: Results of premarital screening of prospective couples in Aseer Region during 2021

Congenital/Infectious Diseases	No.	%
• Positive	1705	6.8
• Negative	23318	93.2
Total	25023	100.0

Figure 1: Results of premarital screening of prospective couples in Aseer Region during 2021

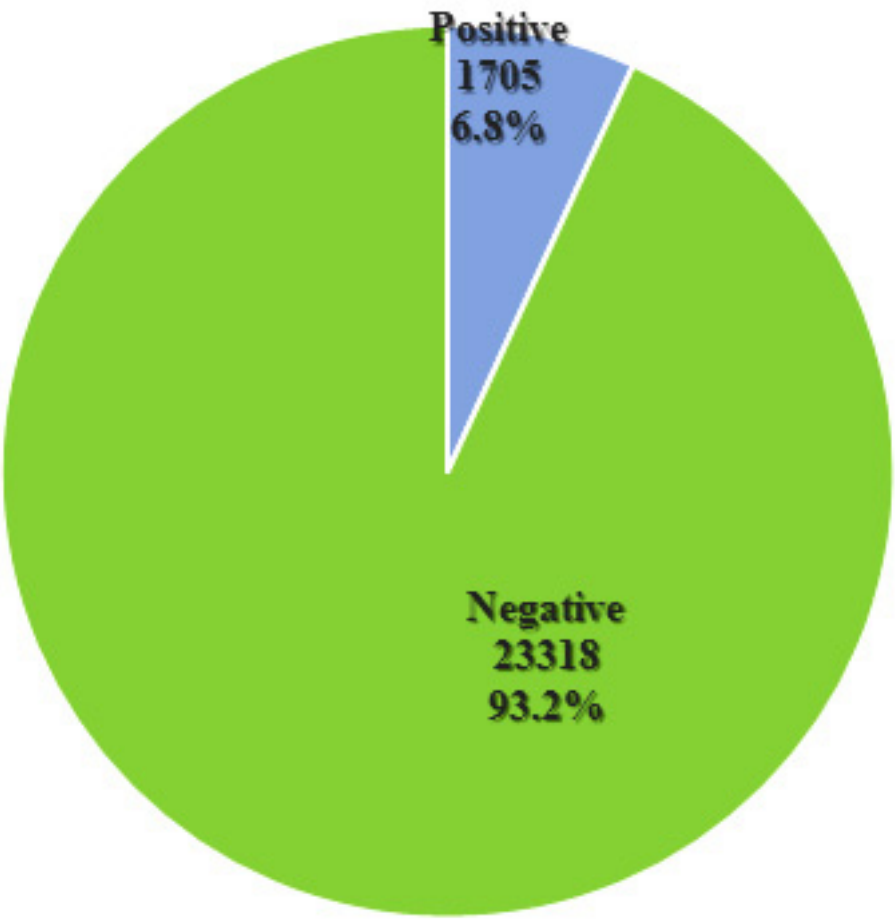

Table 1 and Figure 1 show that during 2021, there were 25,023 of premarital screening of prospective couples in Aseer Region, of whom 6.8% were positive for congenital or infectious diseases.

Table 2: Prevalence of genetic blood diseases among prospective couples who applied for premarital screening in Aseer Region during

Genetic diseases	Males		Females		Total		P value
	No.	%	No.	%	No.	%	
Sickle cell disease							
• Carriers	504	70.9	207	29.1	711	94.9	
• Cases	11	28.9	27	71.1	38	5.1	<0.001
• Total	515	68.8	234	31.2	749	100.0	
β-thalassemia							
• Carriers	181	62.0	111	38.0	292	99.7	
• Cases	1	100.0	0	0.0	1	0.3	0.434
• Total	182	62.1	111	37.9	293	100.0	

Table 2 and Figure 2 show that among prospective couples who underwent premarital screening in Aseer Region during 2021, a total of 749 patients with sickle cell disease were identified (515, 68.8% were males and 234, 31.2% were females), while 293 β-thalassemia patients were identified (182, 62.1% were males, and 111, 37.9% were females).

Figure 2: Genetic blood diseases among prospective couples who applied for premarital screening in Aseer Region during 2021

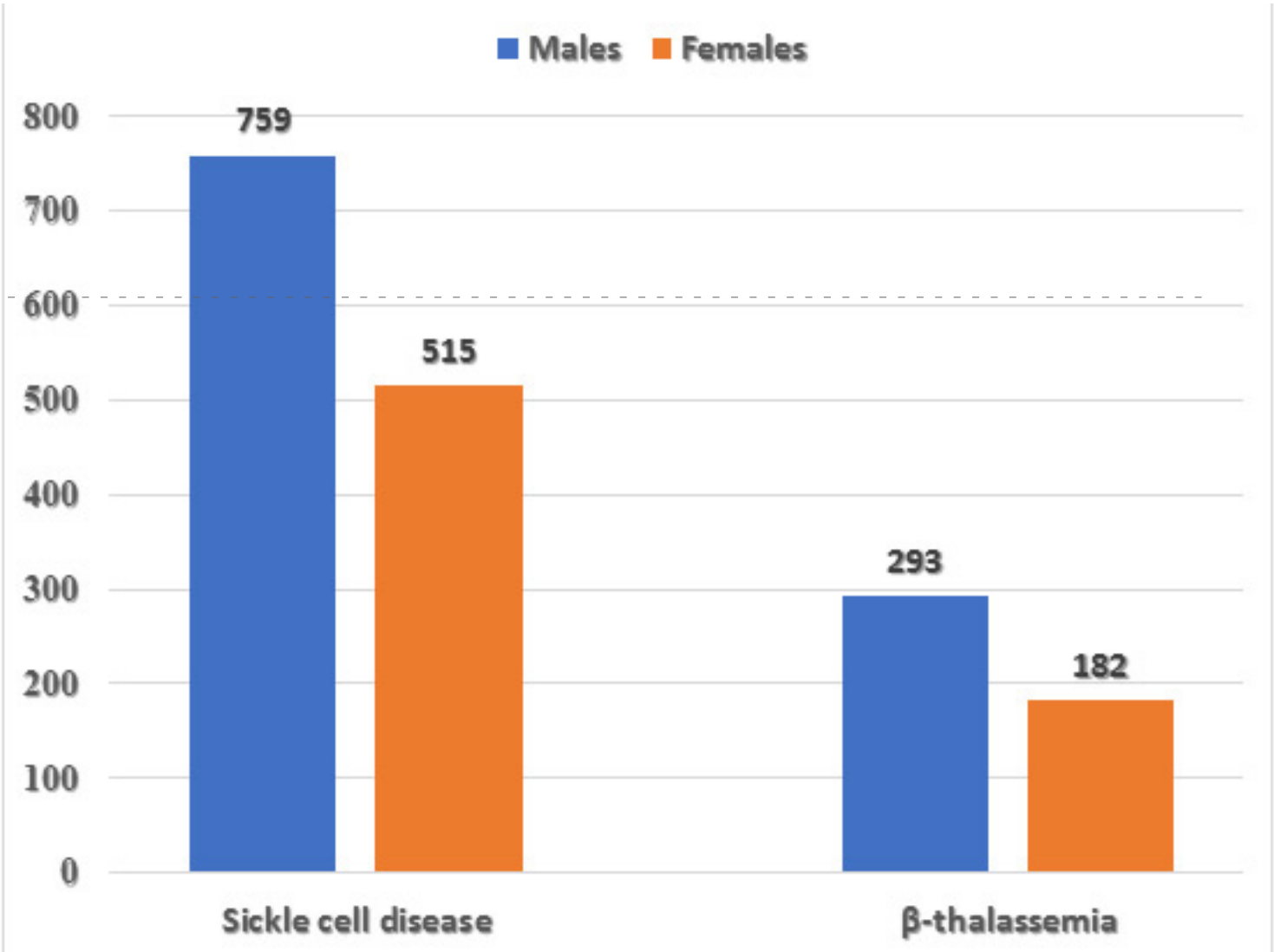

Table 3: Prevalence of infectious diseases among prospective couples who applied for premarital screening in Aseer Region during 2021

Infectious diseases	Males		Females		Total		P Value
	No.	%	No.	%	No.	%	
Hepatitis B virus	100	78.1	28	21.9	128	85.3	
Hepatitis C virus	11	84.6	2	15.4	13	8.7	
Human Immunodeficiency Virus	9	100.0	0	0.0	9	6.0	0.260
Total	120	80.0	30	20.0	150	100.0	

Figure 3: Infectious diseases among prospective couples who applied for premarital screening in Aseer Region during 2021

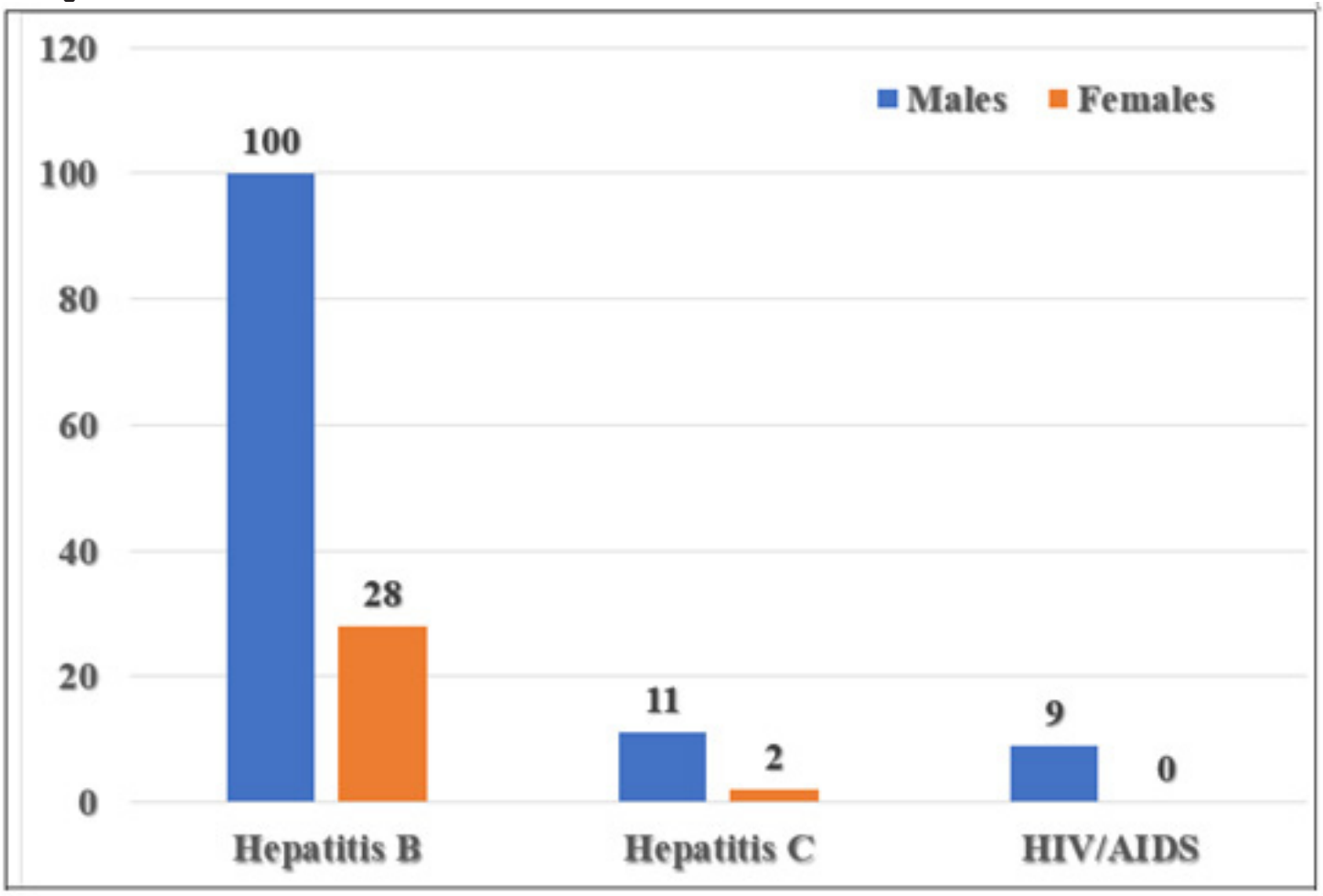

Table 3 and Figure 3 show that a total of 150 patients were diagnosed with chronic infections, of whom 128 patients with hepatitis B were identified (100, 78.1% were males and 28, 21.9% were females), while 13 hepatitis C patients were identified (11, 84.6% were males, and 2, 15.4% were females), and 9 HIV/AIDS patients were identified; all of them were males.

Discussion

The Kingdom of Saudi Arabia is considered to have the highest incidence of hemoglobinopathies among countries in the Middle East. The most common types of these hemoglobinopathies are thalassemia and sickle cell disease (9). Sickle cell anemia poses a continuous significant cause of elevated mortality and morbidity in Saudi Arabia (13), while data concerning the mortality rate associated with thalassemia are still lacking (14).

Results of the present study showed that during 2021, 25,023 prospective couples underwent premarital screening in Aseer Region. Out of those, 6.8% were positive for congenital hemoglobinpathies (i.e., sickle cell anemia) or chronic infectious diseases (hepatitis B, hepatitis C, or HIV/AIDS). Generally, hemoglobinopathies and chronic infectious diseases were more common among examined males than females. Among 749 patients with sickle cell disease, 68.8% were males and, while among 293 β-thalassemia patients, 62.1% were males. Moreover, among 128 patients with hepatitis B, 78.1% were males, and among 13 hepatitis C patients, 84.6% were males, while all identified HIV/AIDS patients were males.

Sickle cell disease is the most common genetic blood disorder. It may cause serious health issues and become life-threatening. Unfortunately, even with superior care being provided, life expectancy in cases of sickle cell disease is still reduced by 30 years (15-16).

Several studies have examined prevalence of hemoglobinopathies in various Saudi cities. Over a 6-year period, the study of Memish and Saeedi (17) that was conducted in all 13 administrative regions of Saudi Arabia reported prevalence rates of 4.5% and 1.8% for sickle cell disease and β-Thalassemia, respectively. Based on data obtained from the PMSGC programs, there were reported prevalence rates of 4.96% and 1.36 for sickle cell disease and β-Thalassemia among examined prospective couples (18). Mir et al. (19) noted that within Saudi Arabia, the eastern and southwestern areas are known to have the highest prevalence of hemoglobinopathies.

In Al Majma'ah City, Saudi Arabia, prevalence of β-thalassemia trait was higher than sickle cell trait in premarital couples. The PMSGC program reported that during February 2004 to January 2005, 4.20%, 0.26%, 3.22% and 0.07% of the participant premarital couples had sickle cell trait, sickle cell disease, β-thalassemia trait and β-thalassemia disease, respectively (20).

As hemoglobinopathies are among the most serious and costly disorders, the PMSGC program was first introduced in Saudi Arabia in 2001 and became mandatory by 2004. The program aims to improve quality of life and reduce the incidence of these disorders. Following launching the program, Saudi Arabia showed a marked reduction in the number of at-risk marriages and predicts to observe a considerable decrease in the burden of the genetic disease in the upcoming years (18).

Memish and Saeedi (17) stated that premarital screening is practically the main preventive measure against inherited hemoglobinopathies. They emphasized the success of the PMSGC program in reducing the detection and prevention of at-risk marriages. Detection of at-risk marriages was reduced by about 60%. However, sickle cell disease remains a predominant hemoglobinopathy accounting for more than 7% of total tests in Southern Saudi Arabia.

Several studies have established the benefits of compulsory premarital screening in minimizing the risk and impact of hereditary blood disorders (21-23).

Alsaeed et al. (18) examined the distribution of disorders throughout Saudi Arabia on a large cohort obtained from 2011 - 2015 PMSGC data. They reported a reduction in those with β-thalassemia traits over the 5-year study period. However, sickle cell disease remained constant from 2011 to 2015.

Premarital screening has been shown by several studies to decrease the rates of hereditary disease by lowering the incidence of genetic blood disorders including sickle cell anemia, thalassemia, and infectious diseases, including hepatitis B, hepatitis C, and HIV/AIDS (24-26).

Interestingly, Melaibari et al. (27) argued that, although Saudi Arabia has mandated the premarital screening program, almost half of the genetically incompatible couples have gone ahead with their marriage decision. The Saudi population is characterized by large families, high maternal and paternal ages, and high levels of inbreeding (28).

Despite the potential benefits of mandatory premarital screening, people continue to marry their intended partners (29). Several studies reported that a significant number of prospective couples do not abide with results of premarital screening tests (23; 30). Social stigma was reported to be one of the main reasons for non-compliance to results of premarital screening. Other stated reasons included interference with God's will, difficulty to cancel marriage, and hurting feelings (23; 31). Additionally, lack of sufficient knowledge regarding premarital screening could explain the negative perception among some individuals (32).

Therefore, ethical and social aspects should be considered for mandatory premarital screening to balance between prevention and autonomy of the couples. There is a need to identify the barriers against uptake of premarital screening tests (33).

Ceglie et al. (34) noted that gender could be a valuable factor in the risk stratification of hemoglobinopathy patients at diagnosis. Moreover, sex hormones were recognized as responsible for gender differences. Similarly, Marsella et al. (35) reported a higher prevalence of thalassemia among males. However, in Eastern Saudi Arabia, Udezue and Girshab (36) found no gender difference in prevalence of sickle cell anemia.

Al-Mazrou et al. (37) reported that the male: female ratio among HIV/AIDS patients in Saudi Arabia is 3:1. Moreover, in Aseer Region, Saudi Arabia Al-Humayed (38) reported a higher prevalence of HbSAg among males than female, but higher prevalence of HCV antibodies among females.

The higher preponderance of hemoglobinopathies and chronic infectious diseases among males in our study may be attributed to the fact that these diseases considerably affect the general condition and appearance of the patients. Therefore, females who are pale due to anemia and those who suffer wasting or weakness are less frequently asked for marriage.

Strength and Limitations

The inclusion of all the study population, and large sample of the study population were important strengths in this study. However, a limitation of this study is that we could not investigate factors related to non-compliance to results of premarital examination. Therefore, future studies should investigate concepts that can induce health behavior to comply with premarital screening recommendations. Future research is needed to explore possible related aspects, such as the impact of social stigma, religion on planned marriage cancellations.

Conclusions

Based on the study results, hereditary hemoglobinopathies, (especially sickle cell disease), and hepatitis B, are commonly identified by premarital examination of prospective couples in Aseer Region. Males are commonly more affected than females. There is a pressing need to provide health education messages to the public regarding the negative impact of consanguinity. Moreover, vaccination against hepatitis B should be enforced to minimize the incidence of this disease. Finally, prospective couples whose offspring is at risk of hereditary diseases should be strongly convinced to comply with marriage cancellations.

References

1. Natarajan J, Joseph MA. Premarital screening for genetic blood disorders — an integrated review on the knowledge and attitudes of Middle Eastern university students. Middle East Fertility Society Journal 2021; 26:19. Doi: 10.1186/s43043-021-00065-4.
2. Piel FB, Hay SI, Gupta S, Weatherall DJ, Williams TN. Global burden of sickle cell anaemia in children under five, 2010–2050: modelling based on demographics, excess mortality, and interventions. PLoS Med 2013; 10(7): e1001484. doi: 10.1371/journal.pmed.1001484.
3. Chawla S, Singh RK, Lakkakula BV, Vadlamudi RR. Attitudes and beliefs among high-and low-risk population groups towards β-thalassemia prevention: a cross-sectional descriptive study from India. J Comm Genet 2017; 8(3):159–166. Doi: 10.1007/s12687-017-0298-4.
4. Al-Shroby WA, Sulimani SM, Alhurishi SA, Bin Dayel ME, Alsanie NA, Alhraiwil NJ. Awareness of Premarital Screening and Genetic Counseling among Saudis and its Association with Sociodemographic Factors: a National Study. Journal of Multidisciplinary Healthcare 2021:14 389–399.
5. Arulogun OS, Adefioye OA: Attitude towards mandatory pre-marital HIV testing among unmarried youths in Ibadan northwest local government area, Nigeria. Afr J Reprod Health 2010, 14(1):83–94.
6. Umar SA, Oche OM: Knowledge of HIV/AIDS and use of mandatory premarital HIV testing as a prerequisite for marriages among religious leaders in Sokoto, North Western Nigeria. Pan Afr Med J 2012, 11:27.
7. Saffi M, Howard N. Exploring the effectiveness of mandatory premarital screening and genetic counselling programmes for β-thalassaemia in the Middle East: a scoping review. Public Health Genom 2015; 18(4):193–203. Doi:10.1159/000430837.
8. Balci YI, Ergin A, Polat A, Atilgan T, Utku U, Koyuncu H. Thalassemia premarital screening program: public view, what has been done, what needs to be done? Int J Hematol Oncol 2014; 29(4):247–252.
9. Makkawi M, Alasmari S, Hawan AA, Al Shahrani MM, Dera AA. Hemoglobinopathies: An update on the prevalence trends in Southern Saudi Arabia. Saudi Med J 2021; 42 (7): 784-789. doi: 10.15537/smj.2021.42.7.20210273.
10. Gowans LJ, Cameron-Christie S, Slayton RL, Busch T, Romero-Bustillos M, Eliason S et al. Missense pathogenic variants in KIF4A affect dental morphogenesis resulting in X-linked taurodontism, microdontia and densinvaginatus. Front Genet 2019; 10:800. Doi: 10.3389/fgene.2019.00800.
11. Kulwicki AD. People of Arab heritage. In: Textbook for transcultural health care: a population approach. Springer, 2021; pp 251–276.
12. Al-Mendalawi MD. RE: Six-year outcome of the national premarital screening and genetic counseling program for sickle cell disease and □-thalassemia in Saudi Arabia. Ann Saudi Med 2011; 31(6):611. DOI: 10.4103/0256-4947.87109.
13. Zaini RG. Sickle-cell anemia and consanguinity among the Saudi Arabian population. Archives of Medicine 2016; 8: 1-3.
14. Abu-Shaheen A, Heena H, Nofal A, Abdelmoety DA, Almatary A, Alsheef M, et al. Epidemiology of thalassemia in Gulf Cooperation Council countries: A systematic review. Biomed Res Int 2020; 2020: 1509501.
15. Kato GJ, Piel FB, Reid CD, Gaston MH, Ohene-Frempong K, Krishnamurti L, et al. Sickle cell disease. Nat Rev Dis Primers 2018; 4: 18010.
16. Xu JZ, Thein SL. The carrier state for sickle cell disease is not completely harmless. Haematologica 2019; 104: 1106-1111.
17. Memish ZA, Saeedi MY. Six-year outcome of the national premarital screening and genetic counseling program for sickle cell disease and ß-thalassemia in Saudi Arabia. Ann Saudi Med 2011; 31: 229-235.
18. Alsaeed ES, Farhat GN, Assiri AM, Memish Z, Ahmed EM, Saeedi MY, et al. Distribution of hemoglobinopathy disorders in Saudi Arabia based on data from the premarital screening and genetic counseling program, 2011-2015.

Journal of Epidemiology and Global Health 2018; 7: S41-S47.
19. Mir SA, Alshehri BM, Alaidarous M, Banawas SS, Dukhyil, Abdul Aziz A. Bin and Alturki MK. Prevalence of hemoglobinopathies (ß-thalassemia and sickle cell trait) in the adult population of al majma'ah, Saudi Arabia. Hemoglobin 2020; 44: 47-50.
20. Alhamdan NA, Almazrou YY, Alswaidi FM, et al. Premarital screening for thalassemia and sickle cell disease in Saudi Arabia. Genet Med. 2007;9(6):372–377.
21. Canatan D, Delibas S. Report on ten years' experience of premarital hemoglobinopathy screening at a center in Antalya, Southern Turkey. Hemoglobin, 2016; 40(4):73. Do: 10.3109/03630269.2016.1170030.
22. Al-Balushi AA, Al-Hinai B. Should premarital screening for blood disorders be an obligatory measure in Oman? Sultan Qaboos University Medical Journal, 2018; 18(1): e24–e29. Doi: 10.18295/squmj.2018.18.01.004
23. Alkalbani A, Alharrasi M, Achura S, Al Badi A, Al Rumhi A, Alqassabi K. Factors Affecting the Willingness to Undertake Premarital Screening Test Among Prospective Marital Individuals. SAGE Open Nursing 2022; 8: 1–7. DOI: 10.1177/23779608221078156.
24. Alhosain A. Premarital screening programs in the Middle East, from a human right's perspective. Diversity & Equality in Health and Care, 2018; 15(2):41–45. Doi: 10.21767/2049-5471.1000154.
25. Bener A, Al-Mulla M, Clarke A. Premarital screening and genetic counseling program: Studies from an endogamous population. International Journal of Applied and Basic Medical Research, 2019; 9(1): 20. Doi: 10.4103/ijabmr.IJABMR_42_18.
25. Gosadi IM. National screening programs in Saudi Arabia: overview, outcomes, and effectiveness. Journal of Infection and Public Health, 2019; 12(5):608–614. Doi: 10.1016/j.jiph.2019.06.001.
26. Hiebert L, Hecht R, Soe-Lin S, Mohamed R, Shabaruddin FH, Mansor SM, et al. A stepwise approach to a national hepatitis C screening strategy in Malaysia to meet the WHO 2030 targets: Proposed strategy, coverage, and costs. Value in Health Regional Issues, 2019; 18(6): 112–120. Doi: 10.1016/j.vhri.2018.12.005.
27. Melaibari M, Shilbayeh S, Kabli A. University students' knowledge, attitudes, and practices towards the national premarital screening program of Saudi Arabia. J Egypt Public Health Assoc 2017; 92(1):36–43. doi: 10.21608/EPX.2018.6648.
28. Al-Gazali L, Hamamy H. Consanguinity and dysmorphology in Arabs. Hum Hered 2014; 77(1-4):93–107. Doi: 10.1159/000360421.
29. Al-Eisawi Z, Jacoub K, Akram A. A large-scale study exploring understanding of the national premarital screening program among Jordanians: Is an at-risk marriage a valid option for Jordanians? Public Understanding of Science, 2020; 30(3): 319–330. Doi: 10.1177/0963662520968468.
30. Al-Farsi OA, Al-Farsi YM, Gupta I, Ouhtit A, Al-Farsi KS, Al-Adawi S. A study on knowledge, attitude, and practice towards premarital carrier screening among adults attending primary healthcare centers in a region in Oman. BMC Public Health, 2014; 14(1): 380. Doi: 10.1186/1471-2458-14-380.
31. Boardman FK, Clark C, Jungkurth E, Young PJ. Social and cultural influences on genetic screening program acceptability: A mixed-methods study of the views of adults, carriers, and family members living with thalassemia in the UK. Journal of Genetic Counseling, 2020; 29(6):1026–1040. Doi: 10.1002/jgc4.1231.
32. Sulaiman KD. Pre-marital test of genetic compatibility for effective child health: An Islamic perspective. Alqalal Journal of Medical and Applied Sciences, 2020; 1(2):1–12.
33. Altaany Z, Khabour OF, Alzoubi KH, Alkaraki AK, Al-Taani G. The perception of Premarital genetic screening within Young Jordanian individuals. Public Health Genomics, 2021; 24(3–4): 182–188. Doi: 10.1159/000517162.
34. Ceglie G, Di Mauro M, Tarissi De Jacobis I, de Gennaro F, Quaranta M, Baronci C, et al. Gender-Related Differences in Sickle Cell Disease in a Pediatric Cohort: A Single-Center Retrospective Study. Front. Mol. Biosci. 2019; 6:140. doi: 10.3389/fmolb.2019.00140.
35. Marsella M, Ammirabile M, Di Matola T, Pepe A, Costantini S, Filosa, A et al. Is there a difference in phenotype between males and females with non-transfusion-dependent thalassemia? A cross-sectional evaluation, Hematology, 2018; 23:8:522-525. DOI: 10.1080/10245332.2017.1413789.
36. Udezue E, Girshab A. Differences between males and females in adult sickle cell pain crisis in eastern Saudi Arabia. Ann Saudi Med. 2004; 24(3): 179–182. doi: 10.5144/0256-4947.2004.179.
37. Al-Mazrou YY, Al-Jeffri MH, Fidail AI, Al-Huzaim N, El-Gizouli S. HIV/AIDS epidemic features and trends in Saudi Arabia. Ann Saudi Med 2005;25(2):100-104.
38. Al-Humayed SM. Hepatitis B and C viral infections in Tihamet Aseer, South-Western Saudi Arabia: Are there gender differences? Saudi J Med Med Sci 2017; 5:110-5.