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Original Article

Outcomes of the premarital screening program in Riyadh Region, KSA in 2021–2022: A cross-sectional study

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الملخص

أهداف البحث: تهدف الدراسة إلى دراسة مدى انتشار مرض فقر الدم المنجلي، والثلاسيميا بيتا، وفيروس نقص المناعة البشرية، وفيروس التهاب الكبد الوبائي (بي)، وفيروس التهاب الكبد الوبائي (سي) وارتباطاتها الديموغرافية في منطقة الرياض.

طريقة البحث: تم استخدام التصميم المقطعي بأثر رجعي. تم أخذ البيانات من البيانات الوطنية لبرنامج الزواج الصحي لمنطقة الرياض. المتغيرات المشاركة في أداة جمع البيانات هي البيانات الديموغرافية، والنتائج المخبرية لاختبارات وتشخيص أمراض الدم والأمصال، وحالة الشهادة. تم استخدام اختبار كولموغوروف-سميرنوف لعينة واحدة لتحديد الحالة الطبيعية للبيانات. تم استخدام نموذج الانحدار اللوجستي المتعدد. تم الإبلاغ عن نسبة الأرجحية مع فاصل ثقة 95٪ لكل من التحليلات ثنائية المتغير ومتعددة المتغيرات.

النتائج: فحصت الدراسة إجمالي 916,295 مشاركا، منهم 452,474 في عام 2021 و463,821 في عام 2022. وكان التوزيع بين الجنسين 51.7% ذكور و48.3% إناث، بمتوسط عمر 43 (± 11.8) في عام 2021 و41 (± 11.9) في عام 2022. ومن بين المشاركين، كان هناك 196 حالة مرض فقر الدم المنجلي و4610 حاملا للمرض. بالإضافة إلى ذلك، ثبتت إصابة 1069 مشاركا بالأمراض المعدية. كان الجنس عاملا بارزا في حالات الإصابة بأمراض فقر الدم المنجلي وفيروس نقص المناعة البشرية وفيروس التهاب الكبد الوبائي (بي) وفيروس التهاب الكبد الوبائي (سي).

الاستنتاجات: تسلط النتائج التي توصلت إليها الدراسة الضوء على أهمية جهود المراقبة والتدخل المستمرة من خلال برامج مثل برنامج فحص ما قبل الزواج والاستشارة الوراثية. تعتبر هذه المبادرات حاسمة لتحديد الأفراد المعرضين للخطر وتقليل عبء الاضطرابات الوراثية والأمراض المعدية من خلال استراتيجيات الصحة العامة المستهدفة. يجب أن تركز الأبحاث المستقبلية على الدراسات الطولية لرصد الاتجاهات وتقييم التأثير طويل المدى للتدابير الوقائية على انتشار الأمراض وتوزيعها في المنطقة.

الكلمات المفتاحية: بيتا ثلاسيميا؛ الأمراض المعدية؛ فحص ما قبل الزواج؛ المملكة العربية السعودية؛ مرض فقر الدم المنجلي

Abstract

Objective: This study investigated the prevalence of sickle cell disease, β-thalassemia, human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) and their demographic associations in Riyadh, KSA.

Method: A retrospective cross-sectional design was used for this study. National data were obtained from The Healthy Marriage Program for the Riyadh region. Variables involved in the data collection tool were demographic data, lab results for hematology and serology tests and diagnosis, and the status of the certificate. A single sample K–S test was used to determine the normality of the data. We used the multiple logistic regression model. The odds ratio (OR) with 95% confidence interval (CI) were reported for both bivariate and multivariable analyses. $P < 0.05$ was considered statistically significant.

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Result: The study screened a total of 916,295 participants, comprising 452,474 in 2021 and 463,821 in 2022. The sex distribution was 51.7% male and 48.3% female, with a mean age (± standard deviation) of 43 (±11.8) in 2021 and 41 (±11.9) in 2022. Among the participants, there were 196 sickle cell disease (SCD) cases and 4610 carriers. Additionally, 1069 participants tested positive for infectious diseases. Sex was a notable factor in SCD, HIV, HBV, and HCV cases.

Conclusion: Our findings highlight the importance of ongoing surveillance and intervention efforts through programs such as premarital screening and genetic counseling programs. These initiatives are crucial for identifying at-risk individuals and reducing the burden of genetic disorders and infectious diseases with targeted public health strategies. Future research should focus on longitudinal studies to monitor trends and assess the long-term impact of preventive measures on disease prevalence and distribution in the region.

Keywords: Infectious diseases; KSA; Premarital screening; Sickle cell disease; β-thalassemia

Introduction

The Premarital Screening and Genetic Counseling (PMSGC) program tests couples planning to marry for common genetic disorders such as sickle cell disease (SCD) and thalassemia, as well as infectious diseases such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV).[1] The aim is to provide medical consultation on the odds of transmitting the abovementioned diseases to the other couple or children and to provide couples with options that help them plan for healthy family.[1] Premarital testing has significantly reduced the rates of hereditary diseases, such as SCD and thalassemia, by identifying individuals carrying these genetic blood disorders.[2] The significance of PMSGC increases with advanced age, as the risk of genetic mutations and chromosomal abnormalities becomes higher.[3] Similarly, it has played a crucial role in decreasing the transmission of infectious diseases such as HBV, HCV, and HIV/acquired immunodeficiency syndrome (AIDS) by detecting and managing these conditions before marriage.[2] As a result, premarital screening has effectively protected individuals, couples, and future generations from the burden of these diseases as well as the financial burden for governments.[4] Hemoglobin disorders such as SCD and thalassemia affect more than 300,000 newborns each year and unfortunately, this number is projected to be increased in the upcoming years.[5,6] UNICEF reported that of the estimated 39.0 million individuals living with HIV globally in 2022, approximately 2.58 million were children within the age group of 0−19.[7] On a daily basis in 2022, approximately 740 children were newly infected with HIV, while about 274 children lost their lives due to AIDS-related causes.[7] It is especially devastating considering that such abnormalities can be prevented if a premarital test is taken by parents and preconception informative counseling is provided.[5]

SCD and thalassemia are the most common inherited diseases in humans. They have a significant prevalence globally, with a particular emphasis on their high occurrence in the Middle East.[8,9] The prevalence of SCD in KSA is estimated to be higher than 45,100 cases per 1,000,000 adults.[10] The highest rates are observed in the Eastern Region, with a prevalence of 9.8 per 1,000, followed by the Asir and Jazan regions, where rates range between 6.8 and 7 per 1000.[11] The prevalence rate of β-thalassemia in KSA is among the highest globally, with 32.1 cases per 1000 in the Northern region and 23.7 cases per 1000 in the Eastern region.[11,12]

In KSA, specific cultural factors such as the prevalence of consanguineous marriages accounting for more than half of marriages, larger family sizes, and advanced parental ages significantly contribute to the elevated occurrence of SCD and thalassemia within the country.[13] The Saudi PMSGC program (currently called The Healthy Marriage Program) is mandatory targeted screening that is part of a primary prevention program available to all Saudi couples who wish to marry.[14] The primary goal of the PMSGC program is to prevent or reduce the number of at-risk marriages, as well as to assess the size and distribution of those who are carriers or suffer from sickle cell anemia or thalassemia.[14] It also aims to make incompatible couples aware of their chances of having children with the diseases, as well as to offer them alternatives to canceling their wedding.[14] All tests are free of charge for Saudi nationals and non-Saudi nationals alike. According to PMSCG guidelines, every couple planning to marry must register with the nearest healthcare center in order to apply for a marriage certificate.[14] To cover all Saudi regions, there are more than 160 accredited premarital screening governmental centers and more than 70 private centers.[1] The most recent Saudi census from the General Authority for Statistics for the Riyadh region reveals that it is home to 8,591,748 individuals. To cater to the population's needs, the Saudi Ministry of Health (MOH) has established 33 governmental centers and 23 private centers to offer premarital screening services.[1,15] Despite the implementation of premarital screening programs in KSA, there are limited data specifically addressing the prevalence of couples affected by genetic disorders such as SCD and β-thalassemia, as well as infectious diseases such as HIV, HBV, and HCV, and the demographic associations of these conditions in the Riyadh region. Addressing these gaps is essential for improving targeted interventions and health policies in the region.

Therefore, this study investigated the prevalence of SCD, β-thalassemia, HIV, HBV, and HCV and their demographic associations in the Riyadh region.

Materials and Methods

The study used a retrospective cross-sectional design. The use of cross-sectional data will allow the simultaneous assessment of the prevalence of premarital test results and the examination of demographic associations. The Healthy Marriage Program includes 33 governmental and 23 private accredited centers in the Riyadh region, providing mandatory screening tests for all couples preparing for marriage. Data were obtained from the Health Electronic Surveillance Network, an integrated digital platform utilized by health authorities, including the MOH, for disease surveillance, reporting, and data collection. Variables in the data collection tool were demographic data (sex, age, and region), lab results for hematology and serology tests and diagnosis, and the status of the certificate. Participants who met the criteria for eligibility were any Saudi couple who underwent premarital screening of SCD, β-thalassemia, HIV, HBV, and HCV in 2021 and 2022 in the Riyadh region.

SPSS statistics version 23 (IBM, Armonk, NY, USA) was used for data entry and analysis. A single sample K−S test was used to determine the normality of the data. To adjust for potential confounding factors, we employed a multiple logistic regression model. The odds ratio (OR) with 95% confidence interval (CI) were reported for both bivariate and multivariable analyses. $P < 0.05$ was considered statistically significant.

We obtained our data from the Saudi MOH after receiving the required approvals from both the Data Management Office and the Central Institutional Review Board (Reference No. 24−20 M). To maintain confidentiality, data were kept anonymous, and no contact was made with the participants.

Results

The study screened a total of 916,295 participants: 452,474 in 2021 and 463,821 in 2022 (Table 1). The sex distribution was 51.7% male and 48.3% female, with a mean age (± standard deviation [SD]) of 43 (±11.8) in 2021 and 41 (±11.9) in 2022 (Table 1). Significant variation in age group distribution was observed in 2021, particularly in the age group of 26−35, which had the highest percentage of participants at 57%, while the ≥66 age group had the lowest at 0.8% (Table 1). In 2022, a similar pattern was observed, with the age group of 26−35 comprising 54% and the ≥66 age group again being the lowest at 0.8% (Table 1).

A total of 196 participants were identified as having SCD, with 102 males and 94 females. In the univariate model, the crude OR for females was 1.016 (95% CI: 0.767−1.345; p = 0.913), while the adjusted OR was 1.039 (95% CI: 0.774−1.395; p = 0.797), showing no significant association (Table 2).

Age group analysis showed no significant association with SCD prevalence, with the exception of the 56−65 and ≥ 66 groups, which had extreme OR values that were not meaningful due to the lack of SCD cases (Table 2).

The study included significant results from both the univariate and multivariate models regarding the prevalence of SCD carriers. Sex was a notable factor, with female participants showing a significantly higher adjusted OR of 1.146 (95% CI: 1.076−1.220; p = 0.001) compared to males (Table 3).

Age group was also a significant factor. All age groups exhibited a significant adjusted OR, with the ≥66 age group showing the highest significant adjusted OR of 2.608 (95% CI: 1.649−4.126; p = 0.001) (Table 3).

The association between β-thalassemia disease and sex was not statistically significant in both univariate (p = 0.907) and multivariate (p = 0.950) models. Age group analysis revealed no significant association for participants aged 15−25 years, 26−35 years, or 36−45 years in both models. No cases were detected in the other age groups (Table 4).

Table 1: Demographic data and the prevalence of participants who were carriers, suffered from SCD and β-thalassemia, and were HIV-, HCV-, and HBV-positive in 2021 and 2022.

Variables		2021	2022	Total	P value
Number of screened subjects		452,474	463,821	916,295	
Sex	**Male**	233,868 (51.7%)	239,548 (51.6%)	473,416 (51.7%)	0.687
	Female	218,606 (48.3%)	224,273 (48.4%)	442,879 (48.3%)	
Age group	**15−25**	90,851 (20.1%)	109,894 (23.7%)	200,745 (21.9%)	0.000
	26−35	258,219 (57.1%)	253,362 (54.6%)	511,581 (55.8%)	
	36−45	68,450 (15.1%)	65,308 (14.1%)	133,758 (14.6%)	
	46−55	21,879 (4.8%)	22,025 (4.7%)	43,904 (4.8%)	
	56−65	9555 (2.1%)	9623 (2.1%)	19,178 (2.1%)	
	≥66	3520 (0.8%)	3609 (0.8%)	7129 (0.8%)	
Number with SCD		94 (0.1%)	102 (0.11%)	196 (0.11%)	0.688
Number of sickle cell carriers (trait)		2250 (2.49%)	2360 (2.54%)	4610 (2.52%)	0.433
Number with β-thalassemia		6 (0.007%)	6 (0.006%)	12 (0.007%)	0.966
Number of β-thalassemia carriers (trait)		1125 (1.24%)	1097 (1.18%)	2222 (1.2%)	0.243
Number of positive couples (HIV, HCV, HBV)		578 (0.13%)	491 (0.11%)	1069 (0.12%)	
Positive HIV		56 (0.06%)	74 (0.08%)	130 (0.07%)	0.151
Positive HCV		72 (0.08%)	49 (0.05%)	121 (0.07%)	0.026
Positive HBV		450 (0.5%)	368 (0.4%)	818 (0.45%)	0.001

HBV: Hepatitis B virus; HCV: Hepatitis C virus; HIV: Human immunodeficiency virus; SCD: Sickle cell disease.

Table 2: Logistic regression model of sickle cell disease.

Sex	Sickle cell disease		Univariate model		Multivariate model	
	Yes	No	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	102	92,153	Reference		Reference	
Female	94	86,267	1.016 0.767−1.345	0.913	1.039 0.774−1.395	0.797
Age group						
15−25	39	38,868	Reference		Reference	
26−35	119	99,694	0.841 0.585−1.207	0.347	0.853 0.584−1.244	0.408
36−45	32	26,089	0.818 0.512−1.306	0.400	0.830 0.513−1.344	0.449
46−55	6	8601	1.438 0.609−3.398	0.407	1.467 0.613−3.511	0.390
56−65	0	3765	1620961.173 0.000	0.983	1663028.075	0.983
≥66	0	1403	996.615	0	1669624.611	0.989

CI: Confidence interval; OR: Odds ratio.

Table 3: Logistic regression model of sickle cell carriers.

Sex	Sickle cell carrier		Univariate model		Multivariate model	
	Yes	No	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	2407	92,153	Reference		Reference	
Female	2203	86,267	1.023 0.965−1.084	0.450	1.146 1.076−1.220	<0.001
Age group						
15−25	1238	38,868	Reference		Reference	
26−35	2495	99,694	1.273 1.188−1.364	<0.001	1.339 1.244−1.440	<0.001
36−45	626	26,089	1.327 1.204−1.463	<0.001	1.400 1.266−1.548	<0.001
46−55	170	8601	1.611 1.370−1.895	<0.001	1.727 1.464−2.037	<0.001
56−65	62	3765	1.934 1.495−2.502	<0.001	2.116 1.631−2.746	<0.001
≥66	19	1403	2.352 1.490−3.712	<0.001	2.608 1.649−4.126	<0.001

CI: Confidence interval; OR: Odds ratio.

Table 4: Logistic regression model of β-thalassemia disease.

Sex	β-Thalassemia		Univariate model		Multivariate model	
	Yes	No	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	6	93,603	Reference		Reference	
Female	6	87,482	0.935 0.301−2.898	0.907	1.039 0.314−3.439	0.950
Age group						
15−25	3	39,661	Reference		Reference	
26−35	6	101,109	1.275 0.319−5.097	0.731	1.293 0.302−5.534	0.729
36−45	3	26,447	0.667 0.135−3.304	0.620	0.677 0.128−3.582	0.646
46−55	0	8655	122196.226	0.978	124629.644	0.978
56−65	0	3806	122196.226	0.986	125361.222	0.986
≥66	0	1407	122196.226	0.991	125862.254	0.991

CI: Confidence interval; OR: Odds ratio.

Sex was not significantly associated with beta thalassemia carrier status in either model. However, the 46–55 age group was significantly less likely to be beta thalassemia carriers compared to the reference group, with an adjusted OR of 0.801 (95% CI: 0.656–0.978; $p = 0.029$) (Table 5).

Sex analysis of HIV showed a significant association in both models. Females were significantly more likely to be HIV, with a crude OR of 3.933 (95% CI: 2.542–6.084; $p < 0.001$) and an adjusted OR of 3.832 (95% CI: 2.429–6.047; $p < 0.001$) (Table 6). Participants aged 26–35 and 36–45 had a lower likelihood of being HIV-positive in the univariate model only (Table 6).

Sex analysis of HBV showed a significant association in both models. Females were significantly more likely to have HBV with a crude OR of 1.991 (95% CI: 1.719–2.307; $p < 0.001$) and an adjusted OR of 1.193 (95% CI: 1.022–1.392; $p = 0.025$) (Table 7). All age groups from 26 to 35 to ≥66 years had a significantly lower likelihood of being HBV-positive compared to the reference in both models (Table 7).

In the analysis of HCV results, females were significantly more likely to be HCV positive in the univariate model, with a crude OR of 2.299 (95% CI 1.552–3.406, $p < 0.001$) (Table 8). The univariate analysis showed a significantly lower likelihood of being HCV positive for all age groups and these associations remained significant in the multivariate model (Table 8).

Table 5: Logistic regression model of beta thalassemia carriers.

Sex	β-thalassemia carrier		Univariate model		Multivariate model	
	Yes	No	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	1104	93,603	Reference		Reference	
Female	1118	87,482	0.923 0.849–1.003	0.060	0.923 0.844–1.008	0.076
Age group						
15–25	497	39,661	Reference		Reference	
26–35	1231	101,109	1.029 0.927–1.143	0.590	1 0.896–1.115	0.995
36–45	314	26,447	1.055 0.916–1.217	0.457	1.023 0.884–1.184	0.756
46–55	130	8655	0.834 0.687–1.013	0.068	0.801 0.656–0.978	0.029
56–65	35	3806	1.363 0.966–1.923	0.078	1.291 0.911–1.832	0.151
≥66	15	1407	1.175 0.701–1.970	0.540	1.104 0.656–1.859	0.709

CI: Confidence interval; OR: Odds ratio.

Table 6: Logistic regression model of HIV results.

Sex	HIV		Univariate model		Multivariate model	
	Positive	Negative	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	105	94,553	Reference		Reference	
Female	25	88,536	3.933 2.542–6.084	<0.001	3.832 2.429–6.047	<0.001
Age group						
15–25	16	40,129	Reference		Reference	
26–35	76	102,225	0.536 0.313–0.920	0.024	0.882 0.504–1.545	0.661
36–45	29	26,716	0.367 0.199–0.676	0.001	0.617 0.329–1.159	0.134
46–55	5	8774	0.700 0.256–1.910	0.486	1.326 0.478–3.682	0.588
56–65	4	3823	0.381 0.127–1.140	0.085	0.828 0.271–2.527	0.740
≥66	0	1422	644112.674	0.990	1515418.451	0.989

CI: Confidence interval; HIV: Human immunodeficiency virus; OR: Odds ratio.

Table 7: Logistic regression model of HBV results.

Sex	HBV		Univariate model		Multivariate model	
	Positive	Negative	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	556	94,118	Reference		Reference	
Female	262	88,309	1.991 1.719−2.307	<0.001	1.193 1.022−1.392	0.025
Age group						
15−25	36	40,113	Reference		Reference	
26−35	152	102,151	0.603 0.419−0.868	0.006	0.644 0.446−0.930	0.019
36−45	367	26,382	0.065 0.046−0.091	<0.001	0.069 0.049−0.098	<0.001
46−55	134	8651	0.058 0.040−0.084	<0.001	0.063 0.043−0.092	<0.001
56−65	102	3731	0.033 0.022−0.048	<0.001	0.037 0.025−0.055	<0.001
≥66	27	1399	0.047 0.028−0.077	<0.001	0.053 0.032−0.089	<0.001

CI: Confidence interval; HBV: Hepatitis B virus; OR: Odds ratio.

Table 8: Logistic regression model of HCV results.

Sex	HCV		Univariate model		Multivariate model	
	Positive	Negative	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Male	86	94,623	Reference		Reference	
Female	35	88,542	2.299 1.552−3.406	<0.001	0.941 0.613−1.445	0.782
Age group						
15−25	2	40,143	Reference		Reference	
26−35	45	102,278	0.113 0.027−0.467	0.003	0.111 0.027−0.461	0.002
36−45	17	26,736	0.078 0.018−0.339	<0.001	0.077 0.018−0.334	<0.001
46−55	8	8770	0.055 0.012−0.257	<0.001	0.053 0.011−0.253	<0.001
56−65	30	3820	0.006 0.002−0.027	<0.001	0.006 0.001−0.026	<0.001
≥66	19	1418	0.004 0.001−0.016	<0.001	0.004 0.001−0.016	<0.001

CI: Confidence interval; HCV: Hepatitis C virus; OR: Odds ratio.

Discussion

The Saudi PMSGC program aims to avoid at-risk marriages and assess the prevalence and distribution of SCD, thalassemia, and infectious disease carriers. The program also informs genetically incompatible couples about their likelihood of producing children with these illnesses and offers options.

Our study investigated the prevalence of SCD, β-thalassemia, HIV, HBV, and HCV among couples in the Riyadh region and explored the demographic associations of these results. We hypothesized that there would be significant demographic associations with the prevalence of these conditions.

In this study, the prevalence of SCD trait in Riyadh was found to be 2.52%, which is higher than previously reported rates in Riyadh region.[16] Compared to Oman, where the population exceeds 5 million and the SCD trait prevalence ranges between 4.8% and 6%, our finding is considered low.[17,18] Sex was shown to be a significant determinant in SCD trait, with females exhibiting a higher adjusted OR. In addition, the study found that older age groups had a much increased probability of being carriers of SCD, with the adjusted OR rising gradually with age. These findings suggest enhanced screening and diagnostic capabilities, better detection, and population changes such as migration or demographic shifts may explain these results.

On the other hand, SCD cases in Riyadh were 0.11%, which is lower than the 0.15% reported in the literature.[16] Changes in healthcare access and awareness over time with effective public health interventions, such as genetic counseling, premarital screening programs, and targeted public health campaigns, may have reduced the number of new SCD cases in Riyadh.[19,20]

The prevalence of the β-thalassemia trait in Riyadh was found to be 1.2% in this study, whereas past researchers have found it to be higher at 2.01%.[16] Our findings support the belief of shifting patterns of thalassemia prevalence across various regions of the globe.[21] The observed pattern of change is mostly influenced by changes in the birth rate of new patients and is largely impacted by preventative efforts, shifts in population, and the premarital screening program.[22,23]

Regarding HIV analysis, we found that females were more likely to be HIV-positive, with both crude and adjusted ORs showing strong associations. On a global scale, females are more susceptible to HIV and have a higher prevalence of infection compared to males.[24,25]

Females had a high likelihood of being HBV- and HCV-positive, and all age groups had a lower likelihood compared to the reference group. In 2021, the prevalence of HBV was reported at 0.5%, decreasing to 0.4% in 2022, whereas the prevalence of HCV was 0.08% in 2021 and decreased to 0.05% in 2022. The decline of HBV and HCV cases can be attributed to the comprehensive efforts of the Saudi MOH, which included a well-structured plan aimed at efficiently managing and eliminating the viral hepatitis epidemic by 2030.[26]

In our study, we found that females were more prone to infectious diseases. A study from China found that females were more likely to be exposed to needle-stick procedures and blood products, particularly during pregnancy, childbirth, and body piercing, which increases the risk of infectious diseases.[27]

Limitations and strengths

This study had several limitations. Data retrieval errors led to the absence of February results in 2021. Our data only included individuals interested in marriage, excluding others from consideration. These limitations need to be taken into account when interpreting the findings. Despite these limitations, the study had notable strengths, namely, a large and diverse sample, which is representative of the Riyadh region.

Conclusion

In conclusion, our findings underscore the importance of continued surveillance and intervention efforts through programs such as the PMSGC. These efforts not only help in identifying at-risk individuals but also contribute to reducing the burden of genetic disorders and infectious diseases through targeted public health strategies. Future research should focus on longitudinal studies to track trends over time and evaluate the long-term impact of preventive measures on disease prevalence and distribution in the region. To address potential confounding effects more effectively, future research should incorporate a broader range of variables, including repeated marriage, occupation, and travel history. By integrating these factors, studies can offer a more comprehensive understanding of the associations between the prevalence of diseases and demographic factors.

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Conflict of interest

The authors have no financial or non-financial competing interests to declare.

Ethical approval

We obtained our data for the study from the KSA Ministry of Health. We received the required approvals from both the Data Management Office and the Central Institutional Review Board (Approval Reference No. 24−20 M) on February 15, 2024. To maintain confidentiality, all data collected were kept anonymous, and no contact was made with the participants.

Authors contributions

SA: Conceptualization, methodology, data analysis, and writing - original draft preparation. SS: Conceptualization, data acquisition, and reviewing. EA: Conceptualization, data analysis, supervision, reviewing and editing. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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