# The prevalence of sickle cell disease in Saudi children and adolescents

## *A community-based survey*

***Mansour M. Al-Qurashi,*** *MBBS, FRCP,* ***Mohammad I. El-Mouzan,*** *MD,* ***Abdullah S. Al-Herbish,*** *FRCP(C),* ***Abdullah A. Al-Salloum,*** *MD,* ***Ahmad A. Al-Omar,*** *MD.*

## ABSTRACT

**الأهداف:** إيجاد معدل إنتشار داء الخلايا المنجلية لدى الأطفال والمراهقين، مع التركيز على اختلاف هذا المعدل بين المناطق المختلفة في المملكة العربية السعودية.

**الطريقة:** تم إختيار عينة مكونة من 45.682 طفل ومراهق واللذين تراوحت أعمارهم حديثي الولادة وحتى عمر 19 عاماً، باستخدام الطريقة العشوائية المتعددة المراحل بحيث تمثل الأسر السعودية في كل منطقة من المناطق الـ13 الإدارية بالمملكة. أُجريت الدراسة باستخدام عينة مقطعية من المجتمع خلال عامي2005–2004م. تتضمن البيانات التاريخ المرضي والفحص السريري، والتي جُمعت عن طريق المسح الشامل من منزل إلى منزل لجميع الأسر السعوديةالمختارة. تم تحليل المعلومات في جامعة الملك سعود بالرياض

**النتائج:** تم اكتشاف 108 حالة من داء الخلايا المنجلية من بين 45.682 طفل ومراهق، وبمعدل انتشار 24 حالة لكل 10.000. وقد تبين من التوزيع الإقليمي للمرض بان المنطقة الشرقية تتقدم على المناطق الأخرى بمعدل 145 حالة لكل 10.000 تليها المناطق الجنوبية، الغربية، ثم الوسطى بمعدل إنتشار 24 لكل 10.000، 12 لكل 10.000، 6 لكل 10.000 على التوالي. لم توجد حالات في المنطقة الشمالية. وكانت نسبة الذكور إلى الإناث 1:1 تقريباً

**خاتمة:** تبين لنا ارتفاع معدل انتشار المرض في المملكة، وكان انتشاره ملحوظ في كلا من المنطقتين الشرقية والجنوبية. يجب أن توضع خطة لتكوين برامج الكشف المبكر لداء الخلايا المنجلية لدى حديثي الولادة على مستوى البلاد أو المناطق، وذلك باستخدام تحاليل الدم المخبرية. تشير هذه الدراسة بان السكان المعرضين للمرض موزعين جغرافياً بشكل غير عام، لهذا السبب فان عمل برامج الكشف المبكر للمرض لمناطق مختارة أفضل من عمل برنامج شامل للبلاد.

**Objective:** To determine the prevalence and regional distribution of sickle cell disease in Saudi children.

**Methods:** A sample size of 45,682 children and adolescents from newborn to 19 years of age was selected by multistage random probability sampling of the Saudi households from each of the 13 regions of the country. The study is cross-sectional, community based, and conducted over 2 years from 2004 to 2005. Data, including history and clinical examination were collected with house-to-house survey of all selected households. Data management and analysis was carried out at King Saud University, Riyadh, Saudi Arabia.

**Results:** Sickle cell disease was detected in 108 of 45,682 children and adolescents with a prevalence of 24 per 10,000. The regional distribution of sickle cell disease showed eastern region dominance with a prevalence of 145 per 10,000, followed by the southern region with a prevalence of 24 per 10,000, western region 12 per 10,000, and central region with 6 per 10,000. No cases were found in the northern regions. The male to female ratio was approximately 1:1.

**Conclusion:** The results of this national wide community-based survey show a high prevalence of sickle cell disease in the community and the disease is more common in eastern and southern regions of the country. National or regional newborn screening programs for sickle cell disease using hematological tests should be planed. This study shows that the population at risk has an uneven geographical distribution. For this reason, selective rather than universal neonatal screening is likely to be more appropriate in the country.

***Saudi Med J 2008; Vol. 29 (10): 1480-1483***

*From the Ministry of Health (Al-Qurashi), Al-Yamamah Hospital, Department of Pediatric (El-Mouzan, Al-Herbish, Al-Salloum), King Khalid University Hospital, King Saud University, and the Children Hospital (Al-Omar), Riyadh Medical Complex, Riyadh, Kingdom of Saudi Arabia.*

*Received 7th July 2008. Accepted 17th September 2008.*

*Address correspondence and reprint request to: Dr. Mansour M. Al-Qurashi, Al-Yamama Hospital, PO Box 60989, Riyadh 11555, Kingdom of Saudi Arabia. Tel. +966 (1) 4914444 Ext. 4030. Fax. +966 (1) 2083060. E-mail: m2_qurashi@hotmail.com*

Sickle cell disease (SCD) is a common hereditary blood disease in Saudi Arabia, the gene for sickle hemoglobin (HbS) results in the substitution of valine for the glutamic acid normally present at the sixth position from the amino terminus of the beta chain of hemoglobin. Various studies were carried out regarding the incidence and prevalence of SCD in children at Saudi Arabia, but these studies described the incidence or prevalence at the level of cites or regions and most of the studies were hospital based.[1-3] The objective of this study is to report the regional prevalence of the disease in a representative sample of each region of the country. Such information should help in planning programs for further studies and provision of health services.[4,5]

**Methods.** This study was part of the Health Profile of Saudi Children and Adolescent Project. It was approved ethically and funded by the King Abdulaziz City for Science and Technology (KACST). A sample of 42,000 children and adolescents was estimated to represent the children and adolescents groups from birth to 19 years of age. Previous studies have shown that the average number of children and adolescents (under 19 years of age) in Saudi households is between 3 and 5. Therefore, a conservative estimation of 3 children and adolescents for each family implies that a total of (42,000/3) 14,000 households were included in this study. These households were randomly selected by multistage probability sampling procedure from a stratified listing based on the updated 2000-2001 population census available at the time of the study design. The details of this procedure were reported in the growth charts article.[6] This process was completely computerized. It was performed with the assistance of the General Directorate of Statistics, Ministry of Planning that provided all details of the selected households in the cities and villages including road and street maps. Pilot study and training of the field workers were conducted in each of the 13 regions. A house to house survey of all selected households was possible and all data were collected during the visitations. The questionnaire includes questions regarding geographical area, family history of SCD, gender, date of birth and past medical history of each child in relation to SCD including availability of any document indicating the diagnosis. The questionnaire was tested in a pilot study and finalized before the actual data collection. Interviewers (doctors and nurses) were recruited in each of the 13 regions and trained to administer the questionnaire under the supervision of the investigators. Physicians performed the clinical examination of each child, member of the field team to assess the general health of children and to look for signs of SCD.

The study included all Saudi children from birth to 19 years old in the selected sample regardless of their health status during the survey; thus, it included both children with symptoms of SCD and those without symptoms who had blood tests and diagnosis because of the family history. Children with sickle trait are excluded from the study.

Data management and analysis was carried out at the Faculty of Medicine, King Saud University, Riyadh, Saudi Arabia. The data was analyzed using the statistical package for social sciences (SPSS). The prevalence of SCD was calculated by counting the number of children with the disease identified during the survey divided by a denominator of the sample size, expressed per 10,000. Chi-square test was used to compare the prevalence in different regions of the country and the whole country.

**Results.** The study required recruitment of more than 60 field teams to cover all selected households in both urban and rural areas in each region. Each team consisted of a minimum of one physician, one nurse; usually one of them was a female, and a chaperon. In addition, at least one of the members of the team was Arab speaking. All the 14,000 households were covered whether on the top of high mountains in the south, or in the middle of the desert of the central region. However, only 11,874 (84.8%) were eligible. The remaining 2,126 households were vacant, occupied by non Saudi families and very few refusals. Nevertheless, this did not affect the needed number of children and adolescents because of the higher family size than that used in the calculation of the sample size. There were 8,689/11,874 (73%) of the households in urban and 27% in rural settlements. The total number of children and adolescents found to have SCD was 108 out of the total sample of 45,682 children and adolescents representing all regions of the Kingdom, indicating a prevalence of 24 per 10,000. Regional variation in the prevalence of SCD was calculated based on the sample size of each region as follows: Western region (Makkah and Medina regions) = 11,194. Central region (Riyadh and Qassim regions) = 10,711. Eastern region = 4,420. Northern region (Jouf, Northern Border, Hail and Tabuk regions) = 8,959. Southwestern region (Assir, Gizan, Najran and Al Baha regions) = 10,398. The regional distribution of SCD showed that the disease was more common in Eastern region with a prevalence of 145 per 10,000, followed by the Southern region with a prevalence of 24 per 10,000

**Disclosure**. This study was approved and funded by the King Abdulaziz City for Science and Technology (KACST), Riyadh, Kingdom of Saudi Arabia (Grant number: AR-20-63).

**Table 1 -** Prevalence of sickle cell disease.

| Regions | Number of cases | | | Sample size | Prevalence per 10,000 |
|---|---|---|---|---|---|
| | Males | Females | Total | | |
| Central | 4 | 2 | 6 | 10,711 | 6 |
| Western | 9 | 4 | 13 | 11,194 | 12 |
| Eastern | 33 | 31 | 64 | 4,420 | 145 |
| Northern | - | - | - | 8,959 | - |
| Southern | 10 | 15 | 25 | 10,398 | 24 |
| Total | 56 | 52 | 108 | 45,682 | 24 |

(**Table 1**). In Western region, the prevalence of SCD was 12 per 10,000, central region prevalence was 6 per 10,000 and there were no patients in the Northern region of the country during the survey. The statistical analysis of the results was performed with chi-square and it was determined that the eastern region has a significantly higher rate of SCD than the entire country sample as a whole ($p$<0.001), while the northern region has a significantly lower level of SCD than the country as a whole ($p$<0.001). The SCD prevalence in the central region was marginally lower than the country as a whole ($p$=0.05). The frequency of SCD in different age groups was estimated. It showed that 30 (28%) children were <2 years, 21 (20%) children were 2-6 years old, 32 (30%) children were 7-12 years old and 25 (23%) children were more than 12 years old. Sickle cell diseases was equally distributed between males and females (ratio 1:1).

**Discussion.** All families have a document indicating that the children were diagnosed to have SCD by physicians and receiving medical care in clinics and hospitals. The study sample, randomly selected by multistage probability procedure is representative of the population of Saudi children and adolescents from birth to 19 years of age. Therefore, the estimated reported prevalence in this study is the most accurate reflection of the general population prevalence reported so far. It is difficult to compare the results of our study with previous reports due to their differences in the study design, sample coverage of the regions and as a whole. The national study reported by El-Hazmi et al[7] is the mostly comparable. As it was a hospital based and the age range of the sample study was from 2 to 60 years; therefore, the overall prevalence is expected to be higher than in the present report (106 versus 24 per 10,000). Although the method was different, the 2 surveys provide similar estimates for the burden of disease. The estimated regional prevalence of SCD in Saudi Arabia is probably more informative than the overall prevalence. Previous reports based on neonatal screening for SCD indicated high prevalence in some parts of the eastern province. El-Mouzan et al found 291 newborn with SCD by screening 29,246 babies in Qateef General Hospital, Dammam Central Hospital and in Al Khobar Teaching Hospital with a prevalence of 99.5 per 10,000.[2] Similarly, Nassrallah et al[1] reported from other parts of the eastern province indicating a prevalence of 108-235 per 10.000. Clearly, these reports although based on neonatal screening it does not represent all parts of the Eastern Province, a finding that may explain the difference with prevalence figures in this study (145 per 10,000). Similarly, a high prevalence of SCD in the Southwest was documented in this study and comparable with the study of El-Hazmi.[7]

The prevalence was 267 per 10,000 in El-Hazmi study and 24 per 10,000 in our study, however the El-Hazmi study is a hospital based and they screened SCD in certain cities of Southwest region while our study is a community based and the obtained sample selected from all region is reasonably representative of the region. Both previous surveys and this present study shows high burden of sickle cell in the eastern and southern region of the country. Al-Hamdan premarital screening study,[8] determined that the highest rates of sickle disease are the one in the eastern and southwestern regions of the country which is consistent with our study. The prevalence of SCD was 12 per 10,000 in the Western region in this study compared to 88 per 10,000 in El-Hazmi et al study.[7] The difference was explained by variation in the methodology. The present study provides low prevalence of SCD in the central region (6 per 10,000), which is similar to previous studies carried out in the central region.[3,7] The prevalence was 9 per 10,000 in El-Hazmi et al study [7] and no cases of SCD was identified in Al-Nuaim et al study.[3] Finally, despite a relatively high representation of the regions in the North, no cases of SCD were found in the random sample of 8,959 children and adolescents. This finding supports those of El Hazmi et al[7] indicating that SCD is still not a problem in the Northern regions. Sickle

cell diseases is frequent in all Middle Eastern countries,[9] our results are compared with similar community-based studies in neighboring countries.[10,11] A community-based study of common hereditary blood disorders was carried out in Oman.[10] The present study in Saudi Arabia include children of wide age range while Omani study was carried out in children <5 years old. The SCD prevalence in Saudi children was 24 per 10,000 while in Omani children is 20 per 10,000. As part of the National Student Screening Project was used to determine the prevalence of genetic blood disorders in Bahrain was carried out for eleventh-grade students from 38 schools (5,685 students).[11] Prevalence of SCD was 120/10,000. Sickle cell diseases have higher prevalence in Bahrain comparing to our results of Saudi children. However, compared to prevalence in the nearest region (Eastern), that has a closer population similarity to Bahrain, the prevalence of SCD would be higher in the Eastern Province of Saudi Arabia (Prevalence was 145/10,000 in Eastern region). Our results are compared also with other populations in the world. Sickle cell disease is a serious health problem in Africa, every year between 200,000 to 230,000 babies are born in Africa with SCD, rates of children born with SCD in Africa varies from one to 300 per 10,000.[12,13] In the United States, SCD affects 26 per 10,000 US babies of African descent.[14,15] In England 2.8 per 10,000 affected infants are born annually with SCD.[16]

This is a community based survey and the data is obtained by history and clinical examination which is supported by medical reports from the concerned hospitals, there was no blood collection in the field during the survey so the study skipped children with sickle cell diseases who didn't have symptoms or family history of the disease since they were not referred to the hospitals for blood tests. However because children with SCD usually have symptoms by 5 years of age,[17] under reporting is smaller problem in older age groups. This limitation is compensated by large sample size in each region.

In conclusion, the results of this study show a high prevalence of SCD in the community. Both present and old national studies of SCD in the kingdom show that the population at risk has an uneven geographical distribution. For this reason, selective rather than universal neonatal screening is likely to be more appropriate in most areas. National programs of public education are essential, as is the education of primary care practitioners. The national study of prevalence of the SCD should be repeated after 10 years in order to assess the expected drop in the prevalence of the SCD in the kingdom after the compulsory application of pre-marital screening of common hereditary blood diseases in KSA for all population in year 2004.[8]

**Acknowledgement.** *The authors thank KACST for the generous funding and support throughout the study. Special thanks to all families, children and health teams who participated in this study.*

## References

1. Nasserullah Z, Al-Jame A, Abu Srair H, Al Qatari G, Al Naim S, Al-Aqib A, et al. Neonatal screening for sickle cell disease, Glucose-6-phosphate dehydrogenase deficiency and beta-thalassemia in QATIF and AL HASA. ***Ann Saudi Med*** 1998; 18: 289-292.
2. el Mouzan MI, al Awamy BH, al Torki MT. Clinical features of sickle cell disease in eastern Saudi Arab children. ***Am J Pediatr Hematol Oncol*** 1990; 12: 51-55.
3. al-Nuaim L, Talib ZA, el-Hazmi MA, Warsy AS. Sickle cell and G-6-PD deficiency gene in cord blood samples: experience at King Khalid University Hospital, Riyadh. ***J Trop Pediatr*** 1997; 43: 71-74.
4. Nietert PJ, Silverstein MD, Abboud MR. Sickle cell anaemia: epidemiology and cost of illness. ***Pharmacoeconomics*** 2002; 20: 357-366. Erratum in: Pharmacoeconomics 2002; 20: 853.
5. Karnon J, Zeuner D, Ades AE, Efimba W, Brown J, Yardumian A. The effects of neonatal screening for sickle cell disorders on lifetime treatment costs and early deaths avoided: a modelling approach. ***J Public Health Med*** 2000; 22: 500-511.
6. El-Mouzan MI, Al-Herbish AS, Al-Salloum AA, Qurachi MM, Al-Omar AA. Growth charts for Saudi children and adolescents. ***Saudi Med J*** 2007; 28: 1555-1568.
7. el-Hazmi MA, Warsy AS, al-Swailem AR, al-Swailem AM, Bahakim HM. Sickle cell gene in the population of Saudi Arabia. ***Hemoglobin*** 1996; 20: 187-198.
8. Alhamdan NA, Almazrou YY, Alswaidi FM, Choudhry AJ. Premarital screening for thalassemia and sickle cell disease in Saudi Arabia. ***Genet Med*** 2007; 9: 372-377.
9. El-Hazmi AF, Warsy AS. Hemoglobinopathies in Arab countries. In: Teebi AS, Farag TI, editors. Genetic disorders among Arab populations. Oxford monographs on medical genetics, No. 30. New York: Oxford University Press; 1999. p. 83-110.
10. Al-Riyami AA, Suleiman AJ, Afifi M, Al-Lamki ZM, Daar S. A community-based study of common hereditary blood disorders in Oman. ***East Mediterr Health J*** 2001; 7: 1004-1011.
11. Al-Arrayed S, Hafadh N, Amin S, Al-Mukhareq H, Sanad H. Student screening for inherited blood disorders in Bahrain. ***East Mediterr Health J*** 2003; 9: 344-352.
12. Makani J, Williams TN, Marsh K. Sickle cell disease in Africa: burden and research priorities. ***Ann Trop Med Parasitol*** 2007; 101: 3-14.
13. Diallo D, Tchernia G. Sickle cell disease in Africa. ***Curr Opin Hematol*** 2002; 9: 111-116.
14. US Preventive Services Task Force. Screening for sickle cell disease in newborns: recommendation statement. ***Am Fam Physician*** 2008; 77: 1300-1302.
15. Driscoll MC. Sickle cell disease. ***Pediatr Rev*** 2007; 28: 259-268.
16. Hickman M, Modell B, Greengross P, Chapman C, Layton M, Falconer S, et al. Mapping the prevalence of sickle cell and beta thalassaemia in England: estimating and validating ethnic-specific rates. ***Br J Haematol*** 1999; 104: 860-867.
17. Davis H, Schoendorf KC, Gergen PJ, Moore RM Jr. National trends in the mortality of children with sickle cell disease, 1968 through 1992. ***Am J Public Health*** 1997; 87: 1317-1322.