# Incidence trends of childhood type 1 diabetes in eastern Saudi Arabia

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## ABSTRACT

**الأهداف:** تحديد معدل حدوث النوع الأول من السكر للأطفال السعوديين الأقل من 15 في عينة من سكان المنطقة الشرقية – المملكة العربية السعودية.

**الطريقة:** أجريت هذه الدراسة المعتمدة على الملاحظة في المرافق الطبية لشركة ارامكو السعودية – الظهران – المنطقة الشرقية و حصرت كل حالات النوع الأول من السكر التي شخصت للأطفال ما دون 15 عام بالإضافة إلى العمر، والجنس، وتاريخ تشخيص هذه الحالات خلال الفترة من 1990 حتى 2007م. تم التأكد من حصر كل الحالات بنسبة 100%.

**النتائج:** تم تشخيص 438 حالة خلال مدة الدراسة. كان متوسط معدل الحدوث السنوي 27.52 لكل 100,000 نسمة مع ملاحظة أن هذا المعدل قد تضاعف في النصف الثاني من مدة الدراسة مقارنة بالنصف الأول، و قد ارتفع المعدل من 18.05 إلى 36.99 لكل 100,000نسمة (95% CI: 26.72-28.32). كانت 21% من الحالات للفئة العمرية أقل من 5 عام، ولم يلاحظ فرق في المعدل السنوي لحدوث السكر لهذه الفئة مقارنة بالفئات العمرية الأكبر. كان 55% من المرضى إناث، و شخصت 40% حالة كيتواسيدوسس.

**خاتمة:** ارتفع المعدل السنوي لحدوث النوع الأول من السكر عند الأطفال السعوديين بوتيرة كبيرة ومقلقة خلال 18 عام الماضية. أصبح وجود قاعدة بيانات شاملة على مستوى المملكة أمراً ضرورياً لدراسة مختلف جوانب المرض في جميع المملكة.

**Objectives:** To assess the epidemiology and incidence rate of type 1 diabetes in children <15 years of age in a subpopulation in the eastern province of the Kingdom of Saudi Arabia (KSA).

**Methods:** This is a subpopulation-based observational incidence study. Admission dates, diagnosis, age, and gender were collected for all Saudi children <15 years of age with new onset type 1 diabetes that received medical care at the Saudi Aramco Medical Services Organization, Dhahran Health Center, Dhahran, KSA during the period 1990-2007. The case ascertainment rate was estimated to be 100%.

**Results:** There were 438 patients diagnosed during the study period. The average incidence rate was 27.52/100,000/year (95% CI: 26.72-28.32), increasing from 18.05/100,000/year in the first 9 years of the study period to 36.99/100,000/year in the last 9 years. Twenty-one percent of patients were <5 years of age, with no significant difference in the rate of increase in the incidence rate of this age group compared to the older age groups. Of the total patients, 55% were females, and 40% presented with diabetic ketoacidosis.

**Conclusion:** The incidence rate of childhood type 1 diabetes increased alarmingly over the past 18 years in our study population. A Kingdom-wide diabetes registry is essential to study the epidemiology of this disease in the whole country.

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Type 1 diabetes is a chronic disease with serious acute and chronic complications. The geographical incidence of type 1 diabetes varies widely worldwide, but overall has increased over the past 3 decades.[1-5] A recent analysis of data on published incidence trends showed that the incidence of type 1 diabetes is increasing globally by 3-5% per year, and the incidence will be 40% higher in 2010 than in 1998.[1] Both genetic and environmental factors were incriminated to explain these variations. The environmental factors leading to

this increase are still speculative and elusive.[6,7] More epidemiological studies are needed to uncover such factors, as well as to plan future strategies to control this disease. Incidence data from the Middle East in general and the Kingdom of Saudi Arabia (KSA) in particular are scarce.[8] This has been attributed to many reasons including lack of diabetes registries, scattered medical facilities, as well as suboptimal capturing of new cases.[9] There are no reported incidence rates for childhood diabetes that represent KSA; one recent study reported a prevalence rate of 109.5/100,000 in those up to 19 years of age with an equal male to female ratio.[10] In this study, the lowest prevalence rate by region was in the eastern province; 48/100,000. Published studies from other Arab countries suggest high incidence rates and many of these countries have been classified in the very high and intermediate categories of the Diamond World Health Organization classification.[4,8] The aim of this study is to report the incidence rate trends of childhood diabetes between 1990 and 2007 in a Saudi subpopulation living in the eastern province of KSA.

**Methods.** This is a subpopulation-based observational study to report the incidence rate of type 1 diabetes among Saudi children registered to receive medical care in Saudi Aramco Medical Services Organization facilities, Dhahran, eastern province of KSA. Saudi Aramco is one of the biggest oil companies in the world, with a workforce of approximately 54,000 employees. The company hospital serves a closed population (employees and their dependents). Eligible children are registered in the company personnel database as soon as their parents are employed, and will be removed from this database when their parents leave the company. The total number of registered children is updated annually, and this constituted our denominator in calculating the incidence rate. The pediatric diabetes registry (established in 1994) was the source of the clinical data. All children diagnosed with new onset type 1 diabetes are added to this registry when they present to our medical facility, this includes the date and age at diagnosis, gender and type of presentation; diabetic ketoacidosis (DKA) versus polyuria and polydypsia (P and P). This registry included all children diagnosed from 1994 onwards. Cases diagnosed before the establishment of the registry and are still <15 years of age were already followed in the pediatric diabetes clinic, so their clinical data were collected from the clinic records and patient's hospital medical files. Secondary ascertainment was performed by reviewing the computerized registry of all children admitted to our medical center with a diagnosis of diabetes mellitus, DKA, or hyperglycemia during the study period. All cases found by this search were verified and added to the clinical data. In our center, all diabetic children are followed in the pediatric diabetes clinic by the Pediatric Diabetes Team. Inclusion criteria included all Saudi children <15 years of age with new onset type 1 diabetes diagnosed between 1990-2007, and eligible to receive medical care at Saudi Aramco medical facilities at the time of diagnosis. It is a company policy that once the employee (parent) leaves the company for any reason (death, resignation, retirement, and so forth), he/she and all the dependents will be removed from the company database including the hospital registry, and will not be considered eligible to receive medical care in our medical center. Children will contribute to the numerator (of the incidence rate) only if they have the diagnosis of new onset type 1 diabetes, while they were on the company database. Exclusion criteria included those children with type 2 diabetes, neonatal diabetes, and diabetes secondary to post-surgical pancreatectomy, pancreatitis, cystic fibrosis, or steroid therapy. In our center, the diagnosis of new onset type 1 diabetes is carried out by a Pediatric Endocrinologist. When any case is suspected clinically to have type 2 diabetes, more confirmatory tests are performed, which includes serum insulin levels, as well as the standard auto-antibodies. We also excluded all non-Saudi children, others receiving medical care off-site, as well as Saudi children who were not part of the denominator population at the time of their diagnosis (such as referrals from outside the studied population; those are mainly very important patients). Admission dates, age, and gender were collected for all studied children who met the inclusion criteria. The incidence rate is expressed as cases per 100,000 children per year with 95% confidence interval (CI). In addition to calculating the overall incidence rate, we divided the 18-year study period into 6, 3-year intervals to better represent the trends and changes in incidence rate. The data was analyzed for 2 age groups; <5 years and 5-14 years to see whether there is a significant difference in the incidence rate between the 2 age groups. The DKA was diagnosed when the serum pH was <7.30, and/or serum bicarbonate <15 mmol/l. Seasonality months of winter included December, January, and February. Spring included March, April, and May. Summer includes June, July, and August. Autumn includes September, October, and November.

Differences and trends in incidence rate with regard to gender, age, presentation, season, and year period were analyzed by the Poisson regression analysis using the Statistical Package for Social Sciences version 17 (SPSS Inc, Chicago, IL, USA). Chi square analysis was used to find out the association between gender, age and presentation as DKA versus P and P. Univariate regression was used for linear relationship between the time in years and gender, age and presentation as DKA versus P and P. The approval to conduct this study was

obtained from the Pediatric Services Division of our institution.

**Results.** A total of 438 patients with new onset type 1 diabetes meeting the inclusion criteria were identified. The average number of registered children is 91,994 (standard deviation: 24281). **Table 1** shows the annual incidence rate throughout the study period. The overall cumulative incidence rate is 27.52/100,000/year (95% CI: 26.72-28.32). The increase in incidence rate throughout the study period is significant ($p$<0.001) with an average annual increase in incidence of 16.8% (95% CI: 14.1-19.4). The overall cumulative incidence rate for the second half of the study period (1999-2007) has doubled compared to the first half. **Figure 1** shows time trends of the incidence rate of type 1 diabetes in 3-year intervals between 1990 and 2007. There is a significant female preponderance with incidence rate of 31.17/100,000/year (95% CI: 26.25-33.80) for females versus 24.07/100,000/year (95% CI: 19.80-26.26) for males ($p$=0.0066). There are 91 patients (21% of total patients) below 5 years of age with an overall incidence rate of 20.72/100,000/year (95% CI: 14.44-21.90). There was no significant difference in the rate of increase in incidence rate in this age group compared to the older age group. In the younger age group, the overall incidence rate for the second half of the study period has doubled compared to the first half. This is similar as well to the older age group (5-14 years) (**Figure 2**). **Figure 3** shows the percentage of patients by age and gender at diagnosis. Obviously, the percentages are higher at 7 and 11 years of age in females, and at 8 and 12 years of age in males. Of the total patients, 262 (60%) presented with P and P (incidence rate is 15.82/100,000/year) compared to 176 (40%) that presented with DKA (incidence rate is 10.63/100,000/year), and the difference in incidence rates between the 2 presentations is significant ($p$<0.001). The incidence rate was highest in autumn (8.2/100,000/year), followed by winter (7.17/100,000/year), then spring (6.7/100,000/year), and summer (5.46/100,000/year). There was no significant difference in incidence rate between autumn and summer ($p$=0.051).

**Discussion.** Our data shows clearly that there is a significant increase in the incidence rate of type 1 diabetes over the study period in our cohort. The incidence rate figures are higher than those reported from other Arab countries, and probably one of the highest rates in the world.[8,11] The incidence rate has doubled in the last 9 years compared to the first 9 years of the study period (**Table 1**). The average annual increment in incidence

**Table 1 -** Annual incidence of type 1 diabetes in children <15 years of age/100,000 SAMSO population from 1990-2007.

| Year | n | Males | Females | Pediatric SAMSO population | Annual incidence rate | 95% CI |
|---|---|---|---|---|---|---|
| 1990 | 6 | 5 | 1 | 59,228 | 10.13 | 06.95 - 13.31 |
| 1991 | 5 | 2 | 3 | 63,466 | 7.88 | 2.93 - 9.85 |
| 1992 | 14 | 7 | 7 | 106,875 | 13.10 | 10.93 - 15.27 |
| 1993 | 15 | 7 | 8 | 110,238 | 13.61 | 11.43 - 15.78 |
| 1994 | 16 | 9 | 7 | 116,513 | 13.73 | 11.60 - 15.86 |
| 1995 | 21 | 6 | 15 | 110,335 | 19.03 | 16.46 - 21.61 |
| 1996 | 20 | 10 | 10 | 116,609 | 17.15 | 14.77 -19.53 |
| 1997 | 41 | 15 | 26 | 110,238 | 37.19 | 33.59 - 40.79 |
| 1998 | 34 | 19 | 15 | 110,887 | 30.66 | 27.40 - 33.92 |
| 1999 | 30 | 14 | 16 | 112,858 | 26.58 | 23.57 - 29.59 |
| 2000 | 30 | 13 | 17 | 102,641 | 29.23 | 25.92 - 32.54 |
| 2001 | 40 | 17 | 23 | 107,832 | 37.09 | 33.46 - 40.73 |
| 2002 | 28 | 12 | 16 | 100,217 | 27.94 | 24.67 - 31.21 |
| 2003 | 45 | 16 | 29 | 89,013 | 50.55 | 45.88 - 55.22 |
| 2004 | 21 | 8 | 13 | 71,843 | 29.23 | 25.28 - 33.18 |
| 2005 | 20 | 12 | 8 | 63,939 | 31.28 | 26.95 - 35.61 |
| 2006 | 26 | 13 | 13 | 54,034 | 48.12 | 42.27 - 53.97 |
| 2007 | 26 | 10 | 16 | 49,123 | 52.93 | 46.50 - 59.36 |
| 1990-2007 | 438 | 195 | 243 | | 27.52 | 26.72 - 28.32 |
| 1990-1998 | | | | | 18.05 | 17.17-18.39 |
| 1999-2007 | | | | | 36.99 | 35.62 - 38.36 |

SAMSO - Saudi Aramco Medical Services Organization, CI - confidence interval

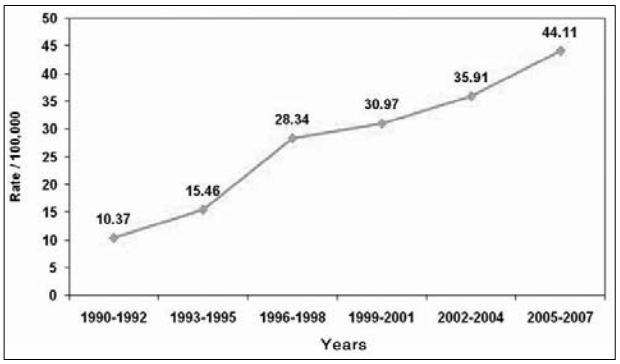


**Figure 1 -** Time trends of incidence rate of childhood type 1 diabetes in 3-year interval, between 1990 and 2007.

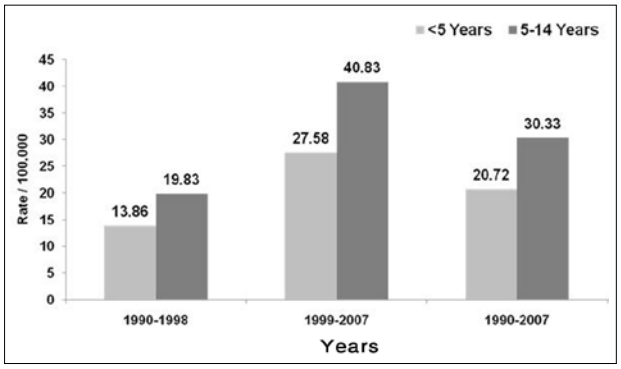


**Figure 2 -** The overall cumulative incidence rate of the second half of the study period (1999-2007) compared to the first half (1990-1998) by age group.

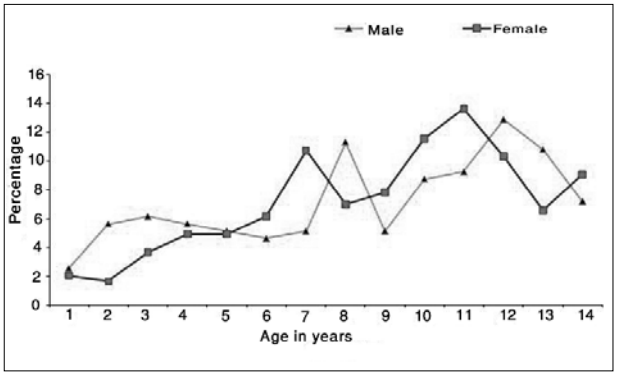


**Figure 3 -** Number of patients with type 1 diabetes by age and gender at presentation shown as a percentage of the total number.

rate is 16.8%, and this increase is very high compared to the reported global increment figure of 3-5% per year.[1]

Incidence estimates based on data from disease registries may be affected by the completeness of ascertainment. It is essential for any precise incidence data to have an accurate numerator and denominator. In the case of diabetes, the number of new cases in a certain population diagnosed over a period of time represents the numerator, and the number of the studied population represents the denominator. In some countries, this is carried out through proper diabetes registries or study groups that monitor and collect all the cases across the country. We are fortunate in our medical center (Saudi Aramco Medical Services Organization in the Eastern province of Saudi Arabia) to serve a closed population. The number of new cases of children with type 1 diabetes is well-captured, and the number of served children is also well-monitored and updated. In our study, we believe that the high ascertainment rate reduces the possibility of under- or overestimation of incidence rate.

**Table 1** outlines the denominators over the study period years. The denominator was relatively small in the first 2 years of the study. A remarkable increase in the denominator occurred in 1992 due to the merging of 2 companies (Saudi Aramco and Saudi Arabian Marketing and Refining Company). The denominator remained relatively constant between the years 1992 and 2002, changing by less than 5% per year in most of these years, which probably reflects the continuous hiring and retirement of company employees, which ultimately affects the total number of registered dependent children. Between 2003 and 2007, there was indeed a gradual drop in the denominator with the biggest drop between 2003 and 2004. The reason behind this change is when the company decided to downsize the medical services, and focus on the core business (oil and gas). This change in policy gradually shifted the medical care of some employees from the company medical center to other designated private medical facilities in the same area. When an employee elects to move his medical care from our medical center to another non-company site, his dependent children will disappear from the database of our medical center, and accordingly from the denominator. Consequently, if one of those dependent children develops new onset type 1 diabetes, he/she will not present to our medical center, and accordingly will not be part of the numerator. The wide fluctuation in incidence rate in the last 6 years may be disturbing, but probably reflects the decreasing numbers of both the denominator and the numerator. However, despite that fluctuation, the incidence remained above 26/100,000/year since 1997.

The genetic contribution to the etiology of type 1 diabetes is very well established,[12] but it is unlikely to be a contributing factor in the global rise in incidence.[13] Changing lifestyle factors, not yet identified, probably explain this phenomenon.[14,15] Although boys and girls in general have a similar risk of type 1 diabetes,[16] some data reported from Europe suggest a female predominance in lower-risk populations, and slight male excess in the high-risk groups.[17] Interestingly, within Europe, all

populations with an incidence higher than 20/100,000 (Sardinia, UK, Italy, Finland, Norway) had male excess, whereas those with a rate below 4.5/100,000 (the Baltic countries, Macedonia, Yugoslavia, Romania) had female excess.[17,18] In our population however, we observed higher incidence among girls while the overall incidence rate was well above 20/100,000. A rapid rate of increase in the incidence rate of childhood type 1 diabetes in the age group less than 5 years, compared to the older age groups has been proposed in some reports.[19] This is not a consistent observation, as large cohorts from different parts of the world did not confirm this finding.[20-22] Our data does not show any significant difference in the rate of increase in incidence rate of this age group compared to the older age group.

Of the total patients, 60% presented with P and P. This is an important parameter to monitor in any epidemiological data to assess the effectiveness of any educational, and preventive measures to reduce the incidence rate of DKA. This is one essential step to lower the mortality and morbidity from childhood type 1 diabetes. The incidence of type 1 diabetes varies markedly over time, both seasonally and annually. In the Northern Hemisphere, the incidence declines during the warm summer months; similarly in the Southern Hemisphere, the seasonal pattern exhibits a decline during the warm months of December and January, implicating a climatic factor.[22,23] Our data showed lower incidence rates in the warmer months of spring and summer compared to autumn and winter similar to the Northern Hemisphere, but we did not find this difference to be statistically significant.

It is often the case that the incidence of childhood type 1 diabetes is not uniform at all ages.[20,21] In our study population, more patients presented at 7 and 11 years of age in girls, as well as, at 8 and 12 years of age in boys. The second peak in each gender probably reflects the timing of puberty, which starts 1-2 years earlier in girls compared to boys.

In conclusion, our data clearly show a significant increase in the incidence rate of childhood type 1 diabetes among Saudi children of Saudi Aramco in the Eastern Province over the study period. Although the total number of overall cases was not large, the study period was long enough to observe and estimate the incidence trends. There was a significant female preponderance, but we did not find any significant difference in the rate of increase in the incidence rate in the younger age group (<5 years) compared to the older age group.

This study was conducted in a subpopulation living in the eastern part of the country, and further studies need to be completed to confirm our results, and inclusion of a nationwide diabetes registry could be beneficial to monitor the increasing trend of type 1 diabetes in this population.

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## Related topics

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