

Prevalence of type 1 diabetes mellitus in school children 6–18 years old in Diyarbakır, Southeastern Anatolian Region of Turkey

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Aim: The frequency of type 1 diabetes mellitus (T1DM) differs according to factors like geographical location, ethnicity, sex, and age. There are few studies investigating T1DM prevalence in the children of Turkey or of the Southeastern Anatolian Region. We aimed to define T1DM prevalence and to investigate geographic and sociodemographic features in school children 6–18 years old living in Diyarbakır.

Materials and methods: The number of children with T1DM and the total number of children at the schools were defined in cooperation with the Diyarbakır Provincial Education Directorate. T1DM prevalence was calculated with the obtained data.

Results: The number of school children 6–18 years old with T1DM in Diyarbakır was 176; and the total number of school children was 419,526. The prevalence of T1DM was found as 0.42/1000. Of the T1DM patients, 94 (53.4%) were female and 82 (46.6%) were male; the female-to-male ratio was 1.2/1. The prevalence of females (0.47/103) was higher than that of males (0.37/103). It was 0.47/103 in the city center of Diyarbakır, higher than that calculated in the other districts of the city (0.35/103).

Conclusion: The defined prevalence of T1DM in school children 6–18 years old in Diyarbakır in the Southeastern Anatolian Region of Turkey is higher than the prevalence reported from Ankara in 1993 and is lower than the prevalence reported from İstanbul in 2009. Results indicated variability in T1DM frequency among regions of Turkey.

Key words: Type 1 diabetes mellitus, prevalence, school children, epidemiology

1. Introduction

Type 1 diabetes mellitus (T1DM) is the most frequently encountered chronic disease of childhood. It has been reported that the incidence of T1DM among children is increasing worldwide. To date, differing data related to T1DM incidence in childhood have been published (1–11). This variability in the incidence of T1DM is explained by ethnic background, geographical region, and socioeconomic development. Moreover, variables such as age, ethnic background, geographical region, and climate, which influence T1DM incidence, have increased the significance of epidemiological trials (9–17). The highest incidences are reported from Finland (>56/100,000), Sweden, and other Scandinavian countries, and also from the Sardinian region of Italy (37.8/100,000). Countries with the lowest incidences are China (0.1–4.5/100,000), Japan, other Asian countries, and Venezuela (0.1/100,000 yearly) (4,6,7,10). In general, T1DM incidence is reported to decrease going from north to south and from west to east in Europe, and while going west to east in Asia

and Africa and the rest of the world (10). Data about the frequency of T1DM among children in Turkey are important, because Turkey is a bridging country between Europe and Asia, or, in other words, between the west and east. However, since epidemiological trials that have investigated T1DM frequency at childhood in Turkey are lacking and national data are not exactly known because of an inadequate registry system, the International Diabetes Federation used the “no data” term for Turkish children in the Diabetes Atlas in 2011, like many Middle East and Asian countries (18).

There are few studies regarding T1DM frequency among children in Turkey. The first of them was conducted in 1993 in Ankara by Hatun, and the second and largest was performed in 2009 in İstanbul by Akesen et al. The reported T1DM prevalences were 0.27/10³ and 0.67/10³, respectively (19,20).

The Southeastern Anatolia Region (SAR) is one of the 7 geographical regions of Turkey as defined by climate, geographical conditions, and sociodemographic structure.

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This region represents part of the eastern section of Turkey, or, in other words, the area closest to Asia. According to our knowledge, there has been no other trial of diabetes incidence in children who live in the SAR until now, apart from a 1-year T1DM incidence trial that was recently performed on children between 0 and 14 years of age in Diyarbakır (21). The aim of the present study was to determine the T1DM prevalence in school children aged 6–18 years in Diyarbakır, which is one of the largest cities in the SAR, and to evaluate the distribution of cases according to geographical features and sociodemographic characteristics.

2. Materials and methods

The study was conducted with the collaboration of the Education Directorate of the Province of Diyarbakır as a part of the “Diabetic Program in School”, after the required approvals were provided by the Diyarbakır Children’s Hospital Management, the Diyarbakır Provincial Health Directorate, and the Diyarbakır Governor’s Office. Data obtained from the electronic database of the Education Directorate of the Province of Diyarbakır revealed that the total number of school children aged 6–18 years in Diyarbakır and its districts was 419,526. On the other hand, according to address-based census results reported by the Turkish Statistical Institute (TSI), the total number of children aged 6–18 years in Diyarbakır was 442,743. For this study, first, a questionnaire, which inquired about whether there were any patients diagnosed with diabetes and receiving insulin therapy and requested their names and contact information, was distributed to all schools for the class teachers to fill out by the Directorate of Education of the province. After these forms were completed, they were sent to our clinic. Data about the numbers of children attending at schools in Diyarbakır were then obtained from the electronic database of the Diyarbakır Provincial Education Directorate. These students were classified according to sex, grade, and location. In Turkey, children start mandatory primary education (for 8 years) at the age of 6, including elementary school (5 years) and intermediate school (3 years), after which they continue with nonmandatory high school (4 years). Thus, the study population included students from the 1st grade of elementary school to the 4th grade of high school (12th grade). In Turkey, children with T1DM are made known to the school authorities and, if present, to the school nurses, in order to allow them to intervene in any emergency situations related to diabetes, such as hypoglycemia (20).

On the other hand, since Diyarbakır Children’s State Hospital is the only center that is authorized to prepare T1DM reports in the city of Diyarbakır by the Social Security Office, all T1DM patients in Diyarbakır are recorded by the hospital. In addition, to confirm the

data reported by the Diyarbakır Provincial Education Directorate, a team, including 1 pediatric endocrinologist and 2 diabetes education nurses, visited 70 schools randomly. All T1DM patients were questioned about their diagnoses and the center at which they were followed, in order to exclude any misinformed children. Both the clinical registry and the patients who were reported by the Diyarbakır Provincial Education Directorate were confirmed by the cross-control system, and the number of students to be excluded was determined. Along with a follow-up of all school children 6–18 years old with T1DM in our clinic, a cross-check of our data with data obtained from school authorities was carried out. Previous studies that used similar methodology suggested to us that our data could be used reliably for the calculation of the prevalence rate of T1DM for Diyarbakır city (20,22,23).

Development indices, which were reported by the State Planning Organization, were used to check whether there was any difference in the calculated prevalence from obtained data according to development indices in the city center and the districts.

2.1. Statistical analyses

SPSS 11.0 for Windows was used for the statistical analysis. Pearson’s correlation analysis was used to test the relationship between T1DM prevalence and development indices. $P < 0.05$ was accepted as statistically significant. Prevalence (number of patients with T1DM / total number of school children 6–18 years old living in Diyarbakır) was indicated in thousands.

3. Results

According to the data obtained from cross-matching the Diyarbakır Provincial Education Directorate figures and the hospital records, the number of school children in Diyarbakır with T1DM was 187. In this cross-matching, we found that 182 (97.3%) of the patients were being followed up with at our clinic, and 5 patients, 3 of whom received their reports from our hospital, were being followed up with at the hospital of the Faculty of Medicine of Dicle University. These results indicated that the hospital data already covered 98.9% of school children in Diyarbakır. This study revealed that 11 of the patients did not attend school. Since it is known that there is a considerable number of children who are not diabetic and do not attend the school in Diyarbakır, the T1DM patients who did not attend school were excluded, and the statistical analyses were performed on 176 patients. According to the data that we obtained from the Diyarbakır Provincial Education Directorate, the total student number at the schools (6–18 years old) was 419,526. Therefore, the T1DM prevalence rate among school children 6–18 years old in Diyarbakır was calculated as $0.42/10^3$ (using the figures of 187 T1DM patients entered in the hospital records and the total

number of children 6–18 years old reported by the TSI, the prevalence was also found to be as $0.42/10^3$. Of the total, 94 (53.4%) of the patients were female and 82 (46.6%) were male; the female/male ratio was 1.2/1. The prevalence of T1DM in females ($0.47/10^3$) was higher than in males ($0.37/10^3$).

The numbers of T1DM patients, total students, and the prevalences in girls and boys according to location (the city center and other districts of Diyarbakır) are given in Table 1. The highest prevalence rate belonged to Kayapınar ($0.89/10^3$), one of central districts, and the lowest belonged to Dicle ($0.10/10^3$) among the city districts. The distribution of patients according to location was as follows: 115 patients lived in the city center, 45 patients lived in the district centers, and 16 patients lived in villages. When prevalence rates in the city center of Diyarbakır and its districts were evaluated, the prevalence in the city center ($0.47/10^3$) was higher than those in the districts ($0.35/10^3$) (Figure 1).

In the city center, the highest prevalence rate was found in one of the new settlement districts, Kayapınar ($0.89/10^3$), and the lowest prevalence rate was observed in one of the oldest settlement districts, Sur ($0.16/10^3$). In the city center of Diyarbakır, T1DM prevalence in private schools ($1.26/10^3$) was higher than in public schools ($0.45/10^3$).

When the distributions of the prevalence rates were evaluated according to school grade of the children, the highest prevalence was observed in grades 7–9 ($0.56/10^3$) (Figure 2).

The prevalences in the intermediate and high schools were equal to each other and higher than those in the elementary schools (Table 2).

Pearson's correlation analysis revealed that there was no statistically significant correlation between the T1DM prevalences by socioeconomic status in the city of Diyarbakır and its districts (Table 3).

4. Discussion

In this study, the prevalence rate of T1DM in the school children of Diyarbakır, which is one of the largest cities in the SAR of Turkey, was found to be 42 per 1000. As far as it is known, this study is the third large-scale study performed

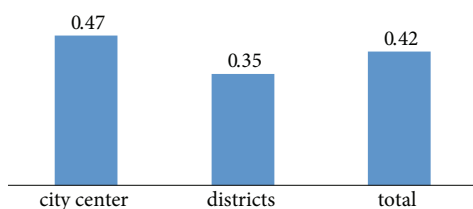


Figure 1. T1DM prevalences in the city center and its districts ($\times 10^{-3}$).

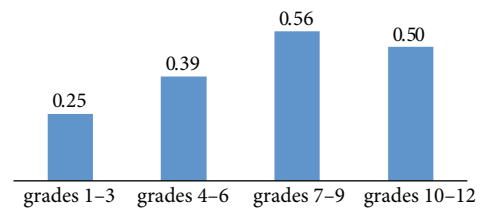


Figure 2. T1DM prevalences according to school grade ($\times 10^{-3}$).

in this age group in Turkey. The first study in this field was performed in 1993 in Ankara, which is a city in the Central Anatolian Region, by Hatun (19). The study was conducted on 330,246 school children and the prevalence was $0.27/10^3$. Akesen et al. (20) performed the largest study in this field in 2009 in İstanbul, where they enrolled 1,630,751 school children, and the reported prevalence was $0.67/10^3$. Although these 3 studies were performed in different regions and at different time intervals, they are significant because they had similar methodology and presented the first data from these regions in Turkey. Moreover, all 3 studies had features to complement each other, as well as having the significance of demonstrating T1DM frequencies in the western, central, and eastern parts of Turkey.

Comparison of these 3 studies indicates that there were significant regional variations in T1DM prevalence in Turkey. This study was the second largest, and the T1DM prevalence was lower than that in İstanbul, but was higher than that reported from Ankara (19,20). However, since that study was conducted 19 years ago by Hatun, and an increase in T1DM, especially in this age group, is a known fact, the results cannot be interpreted as proving that the prevalence of T1DM in Diyarbakır is higher than that in Ankara (19). Moreover, in the study by Akesen et al. in İstanbul, the prevalence of T1DM was 1.5–2 times higher than the prevalence indicated in this study. On the other hand, when the results of the study by Akesen et al. are compared to the study by Hatun, although these 2 studies were conducted at different times and at different centers, Akesen et al. concluded that the differences in prevalences between these 2 studies were due to increased T1DM frequency in childhood (they even commented that this increase was 5.8% annually) (19,20). However, although the prevalence of T1DM in this study was higher than that in the study of Hatun, which was performed 19 years ago, and lower than that in the study of Akesen et al., which was performed in İstanbul 3 years ago, the best conclusion is that the frequency of T1DM is heterogeneous within the different regions of Turkey (Table 5). This outcome may support the view that T1DM decreases worldwide while going from the west to the east (10).

In the light of these 3 studies, the variation in T1DM prevalence across regions in Turkey is similar to that

Table 1. Number of patients with the diagnosis of T1DM, school children aged between 6 and 18 years old, and T1DM prevalence (per 1000) in the center of Diyarbakır and city districts.

District name	Female			Male			Total		
	Number of students with T1DM	Number of students	Prevalence	Number of students with T1DM	Number of students	Prevalence	T1DM (n)	Number of students	Prevalence (/1000)
Bağlar	22	39,249	0.56	14	45,470	0.31	36	84,619	0.42
Bismil	5	15,637	0.32	5	17,120	0.29	10	32,757	0.31
Çermik	2	6595	0.30	3	7066	0.42	5	13,661	0.37
Çınar	1	8935	0.11	2	9705	0.21	3	18,640	0.16
Çüngüş	1	1504	0	0	1520	0	1	3024	0.33
Dicle	1	4851	0.21	0	5325	0	1	10,176	0.10
Eğil	0	2834	0	3	3367	0.89	3	6201	0.48
Ergani	6	14,910	0.40	6	16,742	0.36	12	31,652	0.38
Hani	4	3936	1.02	1	4724	0.21	5	8660	0.58
Hazro	2	2190	0.91	1	2510	0.40	3	4700	0.64
Kayapınar	28	28,220	0.99	27	32,214	0.84	54	60,434	0.89
Kocaköy	1	2161	0.46	1	2422	0.41	2	4583	0.44
Kulp	1	4575	0.22	0	4788	0	1	9363	0.11
Lice	2	2780	0.72	2	3173	0.63	4	5953	0.67
Silvan	1	11,851	0.08	8	13,366	0.60	9	25,217	0.35
Sur	3	15,195	0.20	2	16,489	0.12	5	31,684	0.15
Yenişehir	14	32,923	0.42	7	35,179	0.20	20	68,102	0.29
Total	94	198,352	0.47	82	221,180	0.37	176	419,526	0.42

reported previously from different countries (13–16,24). Similarly, while there was no difference in the frequency of the HLA DQ genotype predisposing to T1DM, a 6-fold increase has been found in the incidence of T1DM between Russian Karelia, on the eastern border of Finland, and Finland (14).

Although the highest prevalence rate was detected among children in grades 7–9, a comparison of our results with the study by Hatun showed that the most marked increase among school children is observed in primary school children. Similarly, when they compared their results with the results of Hatun (19), Akesen et al. (20) reported that the prevalence of T1DM increased by 3.5-fold in primary school children, and the overall increase was found to be 2.5-fold. These findings are consistent with the results that were reported in recent years by other studies, namely that the diagnosis age of T1DM has shifted to younger ages (25–31).

The highest T1DM incidences have been reported from Scandinavian countries like Finland and Sweden, and from Scotland (4,10,16). This high T1DM incidence in the northern European countries starts to decrease, except

for in the Sardinia region in Italy, from the UK (29.8/10⁵) to Central Europe (Czech Republic: 17.2/10⁵; Germany: 18.3/10⁵). The incidence, which decreases in eastern European countries like Slovenia (11.1/10⁵) and Slovakia (13.6/10⁵), is observed as follows in the Balkan states: Greece, 9.9/10⁵; Croatia, 8.9/10⁵; Bulgaria, 9.4/10⁵; Albania, 3.9/10⁵; and Bosnia Herzegovina, 3.5/10⁵ (4,7). Our recently published study (21) on T1DM incidence in Diyarbakır showed an incidence lower than in northern Europe, the United States, Australia, Canada, New Zealand, and rich Middle Eastern countries like Kuwait and Saudi Arabia, whereas it was similar to rates in neighboring countries or nearby Balkan states and some South American countries, like Chile (7–8/10⁵) and Brazil (6.3–10/10⁵) (4,6,7,10,30–34). Similarly, the prevalence of T1DM detected in the present study among school children 6–18 years old in Diyarbakır, a city of the SAR of Turkey, was lower than those in the USA, North Europe, and rich Middle Eastern countries like Kuwait and Saudi Arabia, while being higher than in most Asian countries and similar to that of the Balkan states and Mediterranean countries, excluding the Sardinia region in Italy (10,24,35–38).

Table 2. Current prevalence of T1DM in Diyarbakır, and other results from Ankara (19) and İstanbul (20) according to levels of school.

	Ankara (1993)	İstanbul (2009)	Diyarbakır (2012)
Primary school	0.16	0.57	0.35
Elementary school	0.46	0.69	0.49
High school	0.34	0.92	0.49
Overall	0.27	0.67	0.42

In the present study, the prevalence of T1DM was higher in girls ($0.47/10^3$) than boys ($0.37/10^3$), and this was consistent with previously published data from our clinic (21). Although T1DM is observed in equal rates in general in girls and boys, it is reported in some studies that it was more common in girls than in boys (10). It is reported to be higher in males in countries with high incidences, and higher in females in countries with low incidences (10,35,39–41). The low T1DM incidence observed in our region could explain the higher prevalence of T1DM in girls.

T1DM prevalence differed from 0.1 to $0.67/10^3$ among the districts of Diyarbakır. When central districts were evaluated separately, the highest prevalence ($0.89/10^3$) belonged to the district of Kayapınar. In many studies, it has been reported that T1DM incidence was higher in urban populations when compared to rural ones. It has been suggested that the reason for this is that there is more chance of encountering environmental factors, which could cause T1DM, in the industrial areas, where life was crowded, when compared to areas with a rural life style (15,42–45). In the present study, the prevalence in the city center was higher than that in the districts, and this was consistent with the body of literature. However, when developmental level indices in the district centers, which were published by the State Planning Organization, and related data were considered, it was not found to be a parameter that could explain the differing T1DM prevalences between the districts (Table 3). However, when the central districts were considered, the highest prevalence was observed in Kayapınar, which is a new settlement area with a more urbanized life style and with a better socioeconomic level than the other districts. On the other hand, the lowest prevalence was observed in Sur, which is an old settlement area with a low socioeconomic level and with a rural life style. These findings were in line with the previous literature data indicating that an urbanized life style caused an increased T1DM rate when compared to a rural life style. Moreover, since the prevalence for private schools in the city center was about 3 times higher than that for the government schools in the city center, we might conclude that a high socioeconomic level and an urbanized life style were risk factors for

Table 3. Correlation between socioeconomic development parameters of Diyarbakır city and districts and T1DM prevalences.

	Pearson correlation analysis	
	r	P
General development index	0.053	0.858
Urbanization rate	0.357	0.211
Mean household size	0.025	0.932
General budgeted income per person	0.010	0.974
Employment rate in industry	0.050	0.866
Literacy rate	–0.001	0.997
Infant mortality rate	0.177	0.545

T1DM. However, another reason for these high prevalence rates calculated among private school children might be due to parental choices in these families, including better nursing healthcare and closer monitoring of children in these schools when compared to those in government schools.

It was reported from an ecological analysis of the incidence of childhood T1DM in Europe that the incidence was positively correlated with national indicators of prosperity, such as gross domestic product and low infant mortality (46). However, there was no correlation between the infant mortality rate and T1DM prevalence rate among the school children in our study. A rapid increase of T1DM incidence in the former socialist countries of eastern Europe is most likely related to an increase in wealth in these countries. However, in the present study, personal income (general budgeted income per person) was not correlated with the prevalence of T1DM. In fact, the exact mechanism of how urbanization and wealth affect the frequency of T1DM remains unclear and needs further evaluation.

In conclusion, we can report the current prevalence of T1DM in a large number of school children in Diyarbakır, a city of the SAR region of Turkey, as $0.42/1000$. Although performed in different cities, this figure is higher than that obtained in Ankara, Turkey, in 1993, but lower than in İstanbul, suggesting that prevalence of T1DM is increasing in Turkey. In addition, these data strongly suggest geographical variability and a tendency to decrease from the west to the east between different regions of Turkey. T1DM rates seem to be similar to southern European data, but lower than those of northern Europe, the United States, and rich Middle Eastern countries. Future research should focus on investigating the prevalence in other cities to be better informed about the nationwide prevalence, and to help in understanding the reasons behind the general increase in the prevalence of T1DM and the possible explanations for the differing prevalence among the different regions, and cities, of Turkey.

References

- Green A, Patterson CC. Trends in the incidence of childhood-onset diabetes in Europe 1989–1998. *Diabetologia* 2001; 44: 3–8.
- EURODIAB ACE Study Group. Variation and trends in incidence of childhood diabetes in Europe. *Lancet* 2000; 355: 873–6.
- Karvonen M, Viik-Kajander M, Moltchanova E, Libman I, LaPorte R, Tuomilehto J. Incidence of childhood type 1 diabetes worldwide. Diabetes Mondiale (DiaMond) Project Group. *Diabetes Care* 2000; 23: 1516–26.
- WHO DIAMOND Project Group. Incidence and trends of childhood type 1 diabetes worldwide 1990–1999. *Diabet Med* 2006; 23: 857–66.
- Craig ME, Hattersley A, Donaghue KC. Definition, epidemiology and classification of diabetes in children and adolescents. *Pediatr Diabetes* 2009; 10: 3–12.
- Harjutsalo V, Sjöberg L, Tuomilehto J. Time trends in the incidence of type 1 diabetes in Finnish children: a cohort study. *Lancet* 2008; 24: 1777–82.
- Patterson CC, Dahlquist GG, Gyürüs E, Green A, Soltész G; EURODIAB Study Group. Incidence trends for childhood type 1 diabetes in Europe during 1989–2003 and predicted new cases 2005–20: a multicentre prospective registration study. *Lancet* 2009; 373: 2027–33.
- Soltész G, Patterson CC, Dahlquist G, on behalf of EURODIAB Study Group. Worldwide childhood type 1 diabetes incidence – what can we learn from epidemiology? *Pediatr Diabetes* 2007; 8: 6–14.
- Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 1997; 14: 1–85.
- Borchers AT, Uibo R, Gershwin ME. The geoepidemiology of type 1 diabetes. *Autoimmun Rev* 2010; 9: 355–65.
- Onkamo P, Väänänen S, Karvonen M, Tuomilehto J. Worldwide increase in incidence of type I diabetes; the analysis of the data on published incidence trends. *Diabetologia* 1999; 42: 1395–403.
- Lévy-Marchal C, Patterson CC, Green A; EURODIAB ACE Study Group. Europe and diabetes. Geographical variation of presentation at diagnosis of type I diabetes in children: the EURODIAB study. Europe and Diabetes. *Diabetologia* 2001; 44: 75–80.
- Shubnikov E, Podar T, Tuomilehto J, Nikitin Y. Low incidence of childhood IDDM in district of Novosibirsk (Russia). *Diabetes Care* 1992; 15: 915–7.
- Kondrashova A, Reunanen A, Romanov A, Karvonen A, Viskari H, Vesikari T et al. A six-fold gradient in the incidence of type 1 diabetes at the eastern border of Finland. *Ann Med* 2005; 37: 67–72.
- Cherubini V, Carle F, Gesuita R, Iannilli A, Tuomilehto J, Prisco F et al. Large incidence variation of type I diabetes in central-southern Italy 1990–1995: lower risk in rural areas. *Diabetologia* 1999; 42: 789–92.
- Cardwell CR, Carson DJ, Patterson CC. Higher incidence of childhood-onset type 1 diabetes mellitus in remote areas: a UK regional small-area analysis. *Diabetologia* 2006; 49: 2074–7.
- Gale EA. Spring harvest? Reflections on the rise of type 1 diabetes. *Diabetologia* 2005; 48: 2445–50.
- International Diabetes Federation. IDF Diabetes Atlas, 5th edn. Brussels, Belgium: International Diabetes Federation, 2011. Available at <http://www.idf.org/idf-diabetes-atlas-fifth-edition>.
- Hatun S. Çocukluk çağında diyabet. *Çocuk Endokrinoloji Dergisi* 2003; 1: 15–8.
- Akesen E, Turan S, Guran T, Atay Z, Save D, Bereket A. Prevalence of type 1 diabetes mellitus in 6–18-yr-old school children living in Istanbul, Turkey. *Pediatr Diabetes* 2011; 12: 567–71.
- Demirbilek H, Ozbek MN, Baran RT. Incidence of type 1 diabetes mellitus in Turkish children from the southeastern region of the country: a regional report. *J Clin Res Pediatr Endocrinol* 2013; 5: 98–103.
- Saraç Ö, Toklu Y, Şahin M. The prevalence of pterygium in Ankara: a hospital-based study. *Turk J Med Sci* 2012; 42: 1006–9.
- Kula S, Çevik A, Olguntürk FR, Tunaoglu FS, Oğuz AD, İlhan MN. Distribution of congenital heart disease in Turkey. *Turk J Med Sci* 2011; 41: 889–93.
- Al-Herbish AS, El-Mouzan MI, Al-Salloum AA, Al-Qurachi MM, Al-Omar AA. Prevalence of type 1 diabetes mellitus in Saudi Arabian children and adolescents. *Saudi Med J* 2008; 29: 1285–8.
- Karvonen M, Pitkanen J, Tuomilehto J. The onset of type I diabetes in Finnish children has become younger. *Diabetes Care* 1999; 22: 1066–70.
- Gardener SG, Bingley PJ, Sawtell PA, Weeks S, Gale EAM. Rising incidence of insulin dependent diabetes in children aged under 5 years in the Oxford region. *BMJ* 1997; 315: 713–7.
- Pundziute-Lyckä A, Dahlquist G, Nyström L, Arnqvist H, Björk E, Blohmé G et al. Swedish Childhood Diabetes Study Group. The incidence of type I diabetes has not increased but shifted to a younger age at diagnosis in the 0–34 years group in Sweden 1983–1998. *Diabetologia* 2002; 45: 783–91.
- Schoenle EJ, Lang-Muritano M, Gschwend S, Laimbacher J, Mullis PE, Torresani T et al. Epidemiology of type I diabetes mellitus in Switzerland: step rise in incidence in under 5 year old children in the past decade. *Diabetologia* 2001; 44: 286–9.
- Kandemir N, Açıkgöz E, Yordam N. The epidemiology of juvenile-onset insulin-dependent diabetes mellitus in Turkish children. *Turk J Pediatr* 1994; 36: 191–5.
- Carle F, Gesuita R, Bruno G, Coppa GV, Falorni A, Lorini R et al. RIDI Study Group. Diabetes incidence in 0- to 14-year age-group in Italy: a 10-year prospective study. *Diabetes Care* 2004; 27: 2790–6.
- Charkaluk ML, Czernichow P, Lévy-Marchal C. Incidence data of childhood-onset type I diabetes in France during 1988–1997: the case for a shift toward younger age at onset. *Pediatr Res* 2002; 52: 859–62.

32. Evertsen J, Alemzadeh R, Wang X. Increasing incidence of pediatric type 1 diabetes mellitus in southeastern Wisconsin: relationship with body weight at diagnosis. *PLoS ONE* 2009; 4: e6873.
33. Abdul-Rasoul M, Al-Qattan H, Al-Haj A, Habib H, Ismael A. Incidence and seasonal variation of type 1 diabetes in children in Farwania area, Kuwait (1995-1999). *Diabetes Res Clin Pract* 2002; 56: 153-7.
34. Abduljabbar MA, Aljubei JM, Amalraj A, Cherian MP. Incidence trends of childhood type 1 diabetes in eastern Saudi Arabia. *Saudi Med J* 2010; 31: 413-8.
35. Moussa MA, Alsaied M, Abdella N, Refai TM, Al-Sheikh N, Gomez JE. Prevalence of type 1 diabetes among 6- to 18-year-old Kuwaiti children. *Med Princ Pract* 2005; 14: 87-91.
36. Dokhell TM; Pittsburgh Diabetes Epidemiology Research Group. An epidemic of childhood diabetes in the United States? Evidence from Allegheny County, Pennsylvania. *Diabetes Care* 1993; 16: 1606-11.
37. Zhang H, Xia W, Yu Q, Wang B, Chen S, Wang Z et al. Increasing incidence of type 1 diabetes in children aged 0-14 years in Harbin, China (1990-2000). *Prim Care Diabetes* 2008; 2: 121-6.
38. Dabelea D, Bell RA, D'Agostino RB Jr, Imperatore G, Johansen JM, Linder B et al. Incidence of diabetes in youth in the United States. *JAMA* 2007; 297: 2716-24.
39. Gale EA, Gillespie KM. Diabetes and gender. *Diabetologia* 2001; 44: 3-15.
40. Karvonen M, Pitkaniemi M, Pitkaniemi J, Kohtamäki K, Tajima N, Tuomilehto J. Sex difference in the incidence of insulin-dependent diabetes mellitus: an analysis of the recent epidemiological data. World Health Organization DIAMOND Project Group. *Diabetes Metab Rev* 1997; 13: 275-91.
41. Ostman J, Lönnberg G, Arnqvist HJ, Blohmé G, Bolinder J, Ekblom Schnell A et al. Gender differences and temporal variation in the incidence of type 1 diabetes: results of 8012 cases in the nationwide Diabetes Incidence Study in Sweden 1983-2002. *J Intern Med* 2008; 263: 386-94.
42. Haynes A, Bulsara MK, Bower C, Codde JP, Jones TW, Davis EA. Independent effects of socioeconomic status and place of residence on the incidence of childhood type 1 diabetes in Western Australia. *Pediatr Diabetes* 2006; 7: 94-100.
43. Patterson CC, Carson DJ, Hadden DR. Epidemiology of childhood IDDM in Northern Ireland 1989-1994: low incidence in areas with highest population density and most household crowding. Northern Ireland Diabetes Study Group. *Diabetologia* 1996; 39: 1063-9.
44. Staines A, Bodansky HJ, McKinney PA, Alexander FE, McNally RJ, Law GR et al. Small area variation in the incidence of childhood insulin dependent diabetes mellitus in Yorkshire, UK: links with overcrowding and population density. *Int J Epidemiol* 1997; 26: 1307-13.
45. Patterson CC, Waugh NR. Urban/rural and deprivation differences in incidence and clustering of childhood diabetes in Scotland. *Int J Epidemiol* 1992; 21: 108-17.
46. Patterson CC, Dahlquist G, Soltesz G, Green A. Is childhood-onset type I diabetes a wealth-related disease? An ecological analysis of European incidence rates. *Diabetologia* 2001; 44: 9-16.