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Incidence of type 1 and type 2 diabetes in adults and children in Kronoberg, Sweden☆

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ABSTRACT

All newly diagnosed diabetes in Kronoberg during 3 years was registered, with blood samples from 1630/1666 (97.8%) adults. Those positive for GADab and/or ICA and/or C-peptide < 0.25 nmol/L (0.7%) were classified as type 1 diabetes, the remaining as type 2. Incidence of type 1 in 0–19-year-olds was 37.8(36.1–39.6, 95%CI) and in 20–100 year-olds 27.1(25.6–27.4) per 100 000 and year, it was bimodal with equal peaks in 0–9 year-olds and in 50–80-year-olds. Adults had type 2 incidence 378 (375–380), children 3.1 (2.6–3.6). Among adults 6.9% had type 1 and 93.1% type 2. Among antibodypositive adults ($n = 101$), GADab were present in 90%, ICA in 71%, both GADab and ICA in 61%. Ophthalmology contact as second source was confirmed for 98%. There were no gender differences in type 1 in any age group, small ones in pediatric subgroups. In type 2 men predominated in ages above 40 years. Incidences of type 1 diabetes in both children and adults were very high and as high above age 50 years as in children. Incidence of type 2 was the highest reported from Sweden, to which new diagnostic criteria, a high degree of case-finding, and many elders, may have contributed, but results may also reflect a true increase in incidence of both types of diabetes.

1. Introduction

Type 1 diabetes has formerly been regarded as a disease with onset in childhood and there are numerous reports on incidence of type 1 in children below age 15 years [1]. Type 1 is reported to increase in all parts of the world, except for South and Central America and the West Indies [1]. Data on incidence of type 1 with onset after age 30 years are scarce [2]. For type 2 there are many reports of increasing prevalences [3–5], but fewer regarding incidence [6–10], and type 2 is reported to increase epidemically throughout the world [4,11]. The lower level of fasting plasma glucose (FPG) defining diabetes, 7.0 instead of former 7.8 mmol/L, recommended by WHO in 1998 [12], has to some extent contributed to a higher incidence. In this study we used the lower cut off level for diagnosis of diabetes, pancreatic autoantibodies and C-peptide for classi-

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fication and the method of opportunistic screening for case-finding, meaning that all subjects in contact with the health care system, for any reason, were tested for glucose level [7,13,14]. The importance of classification by etiology has been demonstrated [11,15–18], and also acknowledged by WHO [12], although this is presently under debate [19].

2. Objective

To estimate the incidence of diabetes mellitus in all ages in the defined population of the region of Kronoberg, applying recent criteria for diagnosis and classification.

3. Subjects and methods

3.1. Population

The county of Kronoberg in Southeastern Sweden has 25 public primary health care centers and two hospitals, and all participated in registration and sampling of newly diagnosed diabetic patients. In Sweden almost all medical care is government funded and available to the entire population, and private alternatives are scarce, especially in Kronoberg with three private practitioners dealing with diabetes, who participated in the study but reported no new cases. Children with diabetes in Kronoberg are exclusively treated at the Pediatric Department at the Central Hospital. Mean population size in Kronoberg during the study period was 177 000 inhabitants, 138 000 were aged 18 years or above, 95% were Caucasian. Population statistics of Kronoberg and of Sweden were supplied by regional and national authorities from yearly censuses, with no significant differences between the two populations.

Every person residing in Sweden is given a unique ten digit life-long used identity number at birth, or when immigrating/moving to Sweden. This is used by most authorities, including all health care providers and assures that every individual can be uniquely identified [20].

Studies from Sweden and other parts of Northern Europe have found that general practitioners were in contact with 50–70% of their patient population in one year, and 80-over 90% within 4–5 years [13,21]. In Kronoberg 70% of the population are in contact with the health care system during one year [22] and about 90% during 3 years.

For incidence ratios of childhood type 1 diabetes the whole population is used as denominator [1], and in this study the population is very well controlled, and so were the childhood cases, see below. As for type 2 diabetes the use of the whole population in the denominator was deemed fair since 70% visiting health care in one year and about 90% in three years is far above the 60–75% usually participating in type 2 population screening studies [22,23].

A validation of the registration of newly diagnosed diabetes was done for 80%, randomly selected, of the newly diagnosed adults, who were checked for contact, verified by electronic registry or records, with any of the two departments of Ophthalmology in Kronoberg, for the purpose of diabetes-related eye checkup, to which adult patients with diabetes in Sweden should be referred within the first year. All children and adolescents with diabetes in the area are treated in one center and all children have yearly health checkups at school, supervised by the same Pediatric Department, they have unique personal identity numbers, there are no private clinics for children or diabetes in the area, the Pediatric Department has knowledge of all pediatric deaths during the period (Sweden has a mortality register) and none were due to diabetes or unknown diagnosis [20,24] why the registration of childhood and adolescent cases ought to be complete.

The study was approved by the Ethical Committee of the Medical Faculty of The University of Lund, Sweden.

3.2. Methods

Incidence was studied prospectively from May 1, 1998–April 30, 2001. The method of opportunistic screening [13,14] was applied meaning that all adult patients were tested during routine or acute contact with the medical care system, irrespective of reason for consulting. At the primary health care centers capillary blood was analysed using the HemoCue Glucose System (HemoCue AB, Angelholm, Sweden) and at the hospital departments blood glucose was checked by venous sample. All pathological values were confirmed by further testing meaning several PG samples, fasting and non-fasting. Diabetes was diagnosed according to WHO/ADA criteria if FPG was $\geq$7.0 mmol/L (equal to fasting blood glucose, FBG, $\geq$6.1 mmol/L, $\geq$126 mg/dl) at least twice, or if any random value was $\geq$12.2 (capillary) or $\geq$11.1 (venous) mmol/L (equal to FBG $\geq$11.1 mmol/L, $\geq$200 mg/dl). If the diagnosis was not confirmed by further testing, the subjects were not included in the study. Those cases were very few compared to those included. All new cases of diabetes mellitus aged 18 years or older (excluding secondary and gestational) were registered.

Blood samples were obtained for analyses of islet cell antibodies (ICA), glutamic acid decarboxylase antibodies (GADab), and C-peptide. ICA were analysed with an immunofluorescence assay (the detection limit was 9 JDF-U, sensitivity 100% and specificity 88%) and GADab were analysed with a radioimmunoprecipitation assay, (the lower reference limit was an index of 0.08 corresponding to 21.2 WHO-U/ml, sensitivity 70% and specificity 100%). Both analyses were standardized according to the Diabetes Antibody Standardization Program [25,26]. C-peptide was analysed by radioimmunoassay using a commercial kit (MD315, Euro-Diagnostica AB, Malmo, Sweden). Total variation (sum of intra and interassay variation) was 7%, reference range 0.25–1.0 nmol/L, detection limit 0.13 nmol/L. Data regarding the newly diagnosed 0–17-year-olds was obtained retrospectively from the Pediatric Department. Some but not all children and adolescents had been tested for antibodies and C-peptide.

3.3. Classification of diabetes

Patients positive to any of the antibodies ICA or GADab, or with a C-peptide value $<$0.25 nmol/L were classified as type 1 diabetes [11,12,15–18,27]. Medical records of adults classified

as type 1, and of all children and adolescents, were searched to evaluate presence of acidosis and/or ketonuria, and of early insulin treatment, defined as within 4 weeks of diagnosis of diabetes. Patients without antibodies and with C-peptide $\geq$ 0.25 nmol/L were classified as type 2 diabetes.

3.4. Statistical methods

Statistics were carried out with SPSS (Statistical Package of the Social Sciences, Chicago, Ill.) version 13.0. Incidences were calculated assuming a binomial distribution. Given incidences are per 100 000 inhabitants and year. The incidence data is also presented standardized to the age distribution of the world population [28]. The influence of age and gender on the incidence of diabetes was analysed by logistic regression. A p-value <0.05 was considered significant. All given confidence intervals (CI) are 95%.

4. Results

4.1. Incidence

A mean of 555 (range 530–578) newly diagnosed adults were registered per year. The total incidence of all diabetes mellitus in adults was 402 (399–404). Crude incidences per diabetes type, age and gender, and also estimated incidences standardized to the age distribution of the world population, are given in Table 1. The concordance rate was 98% when comparing incident adult cases of diabetes with the second source, ophthalmology contact, after correcting for 1% that moved out of the area and 13% that died the first years, and were not included in electronic records.

4.2. Incidence of type 1 diabetes

The incidence of type 1 diabetes per 100 000 and year was 27.1 (25.6–27.4) in adults and it peaked twice, in ages 0–9 years, and in ages 50–80 years (Fig. 1). The incidence in ages above 50 years did not in any decade differ significantly from that in the 0–9-year-olds. Incidence in age groups 20–49 years was significantly lower compared to the 0-9-year-olds (20–29 years $p = 0.009$; 30–39 years $p \leq 0.001$; 40–49 years $p = 0.001$) (Table 1). The median age at diagnosis for type 1 in adults, aged 18–100 years, was 57.0 years. Of all type 1 patients aged 0–100 years at diagnosis 57% (91/161) were diagnosed above age 40 years, of adults aged 20–100 years 83% (91/109) were diagnosed above age 40 years.

Within the age group 0–19 years the incidence of type 1 diabetes was significantly higher among the 5–9-year-olds than in the other 5-year-intervals (0–4 years, 10–14 years, 15–19 years, $p = 0.02$). Of the 53 newly diagnosed children and adolescents aged 0–19 years, 49 (92.5%) were diagnosed as type 1 (Table 2). The incidence of type 2 in age groups <25 years was very low (Fig. 2).

Of adults diagnosed as type 1 1% moved out of the area and another 2% were dead within a few years and had no electronic records. For the remaining 97% the concordance rate with the second source was 98%.

4.3. Gender and incidence of type 1 diabetes

There was no significant gender difference in the incidence of type 1 diabetes within the whole population ($p = 0.8$), neither within the whole pediatric population 0–19 years.

In subgroups, however, it was found that girls were over represented in the age groups 0–4 and 10–14 years, boys dominated the age group 15–19 years and there was no gender difference in the age group 5–9 years.

4.4. Autoimmunity, acidosis, ketonuria and early insulin treatment in type 1 diabetes

Of the 1630/1666 (97.8%) adult patients with newly diagnosed diabetes with complete serum samples for classification a total number of 101 (6.2%) had autoantibodies. Of these 101 patients 90% had GADab, 71% had ICA, 61% had both GADab and ICA, 29% had only GADab, and 10% had only ICA. With a serologic classification including positive autoantibodies and/or C-peptide below 0.25 nmol/L, 112 (6.9%) were considered to have type 1 diabetes. Age distribution and grounds for classification of type 1 diabetes in adults are shown in Fig. 3.

Of the 112 diagnosed as type 1 10/66 (15%) presented with acidosis, 37/63 (59%) had ketonuria, and 43/94 (46%) received early insulin treatment.

Of the 26 patients with a C-peptide <0.25 nmol/L only 11 were negative for autoantibodies. Of these 8/11 (73%) received early insulin treatment, 2/10 (20%) had acidosis, 6/7 (86%) had ketonuria, 9/11 (82%) had a BMI $\leq$ 26, median 22.0, median age was 47 years, range 26–79 years.

Of those aged 0–17 years at diagnosis 8/48 (17%) presented with acidosis. All children and adolescents received early insulin treatment.

4.5. Incidence of type 2 diabetes

Of the 1529 (93.8%) who were autoantibody negative 1518 (93.1%) had a C-peptide level of $\geq$0.25 nmol/L and were classified as type 2 diabetes.

Incidence of type 2 diabetes in adults $\geq$18 years was 378 (375–380). The incidence of type 2 diabetes peaked at ages 65–85 years, and increased with age from 20 to 79 years ($p < 0.001$) with no further increase in ages above 80 years. The adults with newly diagnosed type 2 diabetes had a median age of 67.0 years. Of all type 2 diabetes 96% were diagnosed above age 40 years.

4.6. Gender and incidence of type 2 diabetes

The incidence of type 2 diabetes was 16% higher for males in all age groups above age 40 years ($p < 0.001$). Two boys and two girls, had type 2 diabetes.

4.7. Type 2 diabetes in children and adolescents

Only four (8.0%), all aged 10–14 years, had type 2 diabetes. They were all initially treated with insulin but three were switched to treatment with oral antihypoglycemic agents within 2 years. All four were negative for GADab and IA-2Aab. Their mean C-peptide was 1.2 nmol/L. No retrospective information on ketonuria was available.

Table 1 – The incidence rates and 95% confidence intervals (cases per 100,000 and year) of diabetes mellitus in Kronoberg 1998–2001

Age (years)	Kronoberg All				Males				Females				Standardized to the world population All			
	Population	New cases	Incidence		Population	New cases	Incidence		Population	New cases	Incidence		Population	New cases	Incidence	
Years	At risk	*n*		95% CI	At risk	*n*		95% CI	At risk	*n*		95% CI	at risk	*n*		95% CI
Type 1																
0–9	20 493	29	47.2	44.3–50.1	10 592	12	37.8	34.2–41.6	9901	17	57.2	52.8–61.9	38 962	55		
10–19	22 686	20	29.4	28.0–32.1	11 684	9	25.4	23.6–28.4	11 002	11	33.3	30.2–36.6	31 878	28		
20–29	21 949	13	19.7	18.0–21.7	11 471	9	26.2	23.3–29.2	10 478	4	12.7	10.7–15.0	28 336	17		
30–39	22 749	8	11.7	10.4–13.2	11 818	6	16.9	14.7–19.4	10 930	2	6.1	4.8–7.7	21 252	7		
40–49	23 332	14	20.0	18.2–21.9	11 825	6	16.9	14.7–19.4	11 508	8	23.2	20.5–26.0	21 252	14		
50–59	23 970	26	36.1	33.8–38.6	12 314	17	46.0	42.3–49.8	11 656	9	25.7	22.9–28.8	15 939	18		
60–69	17 017	18	35.3	32.5–38.1	8315	8	32.1	28.4–36.0	8707	10	38.3	34.4–42.5	12 397	13		
70–79	15 150	25	55.0	51.4–58.7	6953	9	38.3	33.9–43.0	8197	16	65.1	55.9–66.4	5313	9		
80–100	9756	8	27.3	24.6–30.7	3699	3	27.0	22.0–32.8	6062	5	27.4	23.4–31.8	1771	2		
0–19	43 179	49	**37.8**	36.1–39.6	22 276	21	**31.4**	29.3–33.7	20 903	28	**44.7**	41.5–47.6	70 841	83	**39.0**	37.6–40.5
20–100	133 923	109	**27.1**	25.6–27.4	66 395	58	**29.1**	27.8–30.4	67 538	54	**26.7**	25.5–27.9	106 261	80	**25.1**	24.2–26.0
0–100	177 102	161	**30.3**	29.5–32.2	88 671	79	**29.7**	28.6–31.3	88 441	82	**30.9**	29.8–32.1	177 102	163	**30.7**	29.9–31.5
0–39	87 877	70	26.6	25.6–27.8	45 565	36	29.7	28.6–31.3	42 311	34	26.8	25.3–27.9	120 429	107	29.6	28.7–30.6
40–100	89 225	91	34.0	32.8–35.2	43 106	43	33.3	31.6–35.0	46 130	48	34.7	33.0–36.4	56 673	55	32.3	30.9–33.8
Type 2																
0–9	20 493	0	0	0	10 592	0	0	0	9901	0	0	0	38 962	0		
10–19	22 686	4	5.6	4.9–6.9	11 684	2	5.7	4.4–7.3	11 002	2	6.1	4.7–7.6	31 878	6		
20–29	21 949	16	24.3	22.3–26.4	11 471	7	20.3	17.9–23.1	10 478	9	28.6	25.5–32.0	28 336	22		
30–39	22 749	42	61.5	58.4–64.7	11 818	19	54	49.7–57.8	10 930	23	70.1	65.5–75.0	21 252	39		
40–49	23 332	143	204	199–210	11 825	84	237	229–245	11 508	59	171	164–178	21 252	130		
50–59	23 970	298	414	408–421	12 314	173	468	459–477	11 656	125	357	349–366	15 939	206		
60–69	17 017	356	697	690–704	8315	186	746	736–755	8707	170	651	641–661	12 397	262		
70–79	15 150	392	863	857–868	6953	201	964	959–968	8197	191	777	767–786	5313	139		
80–100	9756	271	926	921–931	3699	111	1000	1000–1000	6062	160	879	871–888	1771	50		
0–19	43 179	4	**3.1**	2.6–3.6	22 276	2	3.0	2.3–3.8	20 903	2	3.2	2.5–4.0	70 841	6	**2.6**	2.3–3.0
20–100	133 923	1518	**378**	375–380	66 395	**781**	392	388–396	67 538	**737**	364	360–367	106 261	844	**265**	262–267
0–100	177 102	1522	**287**	284–289	88 671	**783**	294	291–297	88 441	**739**	279	276–282	177 102	850	**160**	158–162
0–39	87 877	62	23.5	22.5–24.5	45 565	28	20.5	19.2–21.8	42 311	34	26.8	25.3–28.4	120 429	69	18.5	17.7–19.3
40–100	89 225	1460	545	542–549	43 106	755	584	579–589	46 130	705	509	505–514	56 673	783	460	456–465

Populations are mean 1998–2001 in Kronoberg. In bold the main incidence numbers.

Table 2 – Incidence of diabetes mellitus in children and adolescents per 100 000 and year in Kronoberg

Age	All				Males				Females			
	Population at risk	*n*	Incidence	CI	Population at risk	*n*	Incidence	CI	Population at risk	*n*	Incidence	CI
Type 1												
0–4	8888	6	22.5	19.5–25.8	4561	1	7.3	5.2–10.1	4328	5	38.5	33.0–44.5
5–9	11 605	23	69.3	64.7–74.2	6032	11	60.8	54.9–67.0	5574	12	71.8	65.1–78.9
10–14	11 665	11	31.5	28.4–34.8	6004	3	16.7	13.6–20.2	5661	8	47.1	41.8–52.8
15–19	11 021	9	27.2	23.7–28.9	5680	6	35.2	31.5–33.7	5341	3	18.7	15.9–22.1
0–19	43 179	49	**37.8**	36.1–40.0	22 277	21	**31.4**	29.3–33.7	20 904	28	**44.6**	41.9–47.5
0–14	32 158	40	**41.5**	39.3–43.7	16 597	15	**30.1**	27.6–32.8	15 563	25	**53.5**	50.0–57.2
Standardized to the world population												
0–14	54 902	68	**41.9**	40.2–43.6	27 451	25	**31.1**	28.5–33.9	27451	43	**52.2**	49.6–54.4
Type 2												
0–4	8888	0	0		4561	0	0		4328	0	0	
5–9	11 605	0	0		6032	0	0		5574	0	0	
10–14	11 665	4	11.4	9.6–13.5	6004	2	11.1	8.7–14.0	5661	2	11.8	9.2–14.8
15–19	11 021	0	0		5680	0	0		5341	0		0
0–19	43 179	4	**3.1**	2.6–3.6	22 277	2	**3.0**	2.3–3.8	20 904	2	**3.2**	2.5–4.0
0–14	32 158	4	**4.1**	3.5–4.9	16 597	2	**4.0**	3.1–5.1	15 563	2	**4.2**	3.3–5.4
Standardized to the world population:												
0–14	54 902	4	**2.4**	2.0–2.9	27 451	2	**2.4**	1.9–3.1	27 451	2	**2.4**	1.9–3.1

Populations are mean 1998–2001 in Kronoberg. In bold the main incidence numbers.

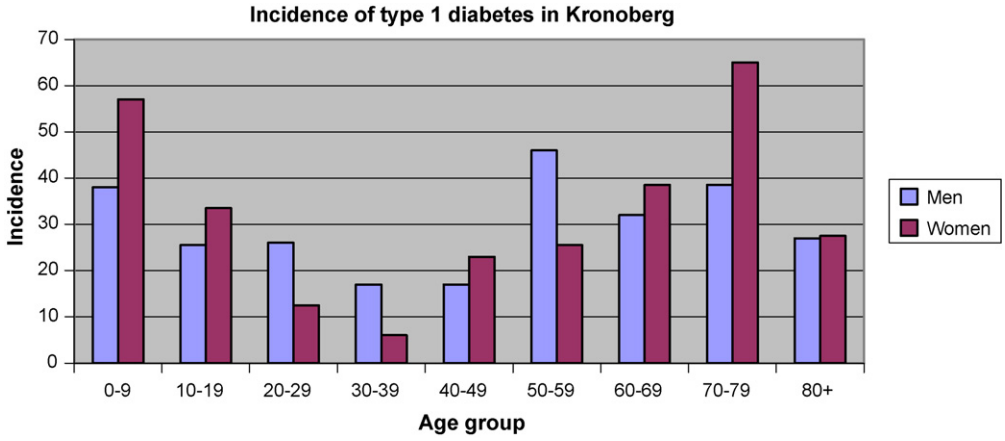

Fig. 1 – Incidence of type 1 diabetes per 100 000 inhabitants and year.

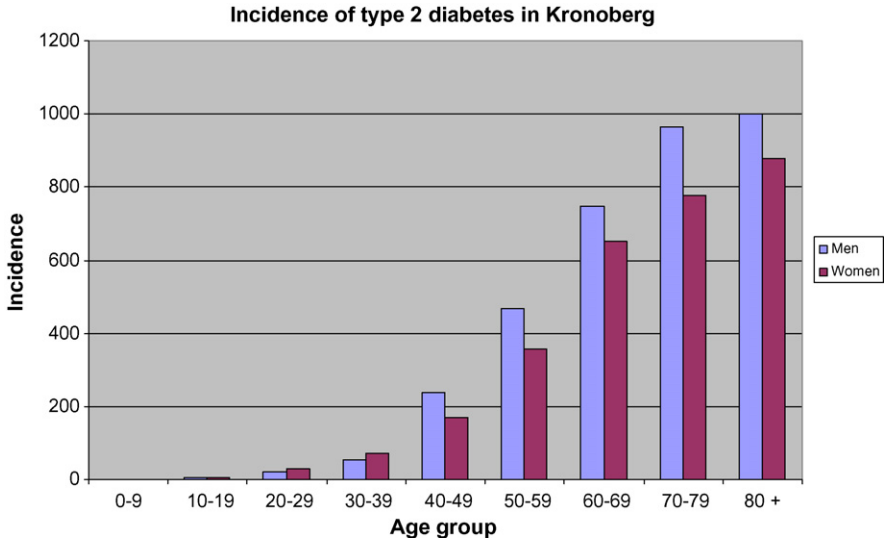

Fig. 2 – Incidence of type 2 diabetes per 100 000 and year.

5. Discussion

5.1. *Incidence of type 1 diabetes*

Our findings confirmed that new cases of type 1 diabetes were diagnosed in all age groups. We found the highest incidence among children in the age group 5–9 years, but incidence of type 1 diabetes peaked not only during childhood and adolescence,

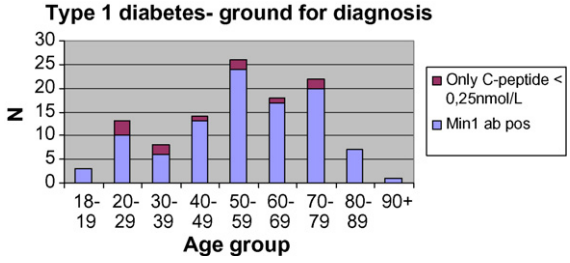

Fig. 3 – Age distribution and ground for diagnosis in type 1 diabetes. N = number of new cases during three years.

since a peak just as high was observed in ages 50–80 years. Our two-peak incidence agreed with studies from Rochester, Minnesota 1960–1969 [6], Denmark 1973–1977 [29], and Finland 1983–1986 [30] which all described bimodal incidences, using clinical classification. All these previous studies describe the peaks appearing close to puberty and in or after the fifth decade, similar to our study in Kronoberg. We found lower incidences in ages 20–49 years similar to findings from Rochester and Denmark, and from Finland 1992–1996 [6,29,34].

The incidences found in this study in Kronoberg of type 1 were among the highest reported in the world, and in accordance with previous observations of incidence during childhood and adolescence from Sweden [1]. The classification does follow the latest WHO recommendations [11,12,27]. The highest incidences of type 1 in childhood have been reported from Northern Europe, especially Finland (incidence 45), with the exception of Iceland, but also from Sardinia, Italy (38.8) and Newfoundland, Canada (35.9) [1,31–33]. Finland has reported very high incidences of type 1 diabetes in children and adolescents, and recently for young adults as well, with figures

similar to those from Kronoberg (if time of registration and reported yearly increase are taken into account) and within the reported age groups decreasing with age, also similar to Kronoberg for those age groups [34].

For confirmation of case finding see Sections 3.1 and 4.2 for our study, the information leading to the well grounded estimate that for type 1 diabetes in children and adolescents confirmation/ascertainment ought to be 100%, comparable to what was reported from Sweden in the DiaMond study 1990–1999 [1].

5.2. *Autoimmunity and ketoacidosis*

Of the newly diagnosed adult patients we found that 6.9% were type 1, which is in accordance with another serologically classified Swedish study that found 9.4% type 1 in ages 40–75 years [9]. The UKPDS found 11.6% autoantibody positive patients aged 25–65 years [35] while a recent Italian study [36] found a lower frequency. It has been shown that clinical classification alone is not reliable and tends to underestimate the amount of autoimmune diabetes, which our data also supports [15–17,27,37,38].

Ketoacidosis was present at diagnosis in 15% of the adults and in 17% of the children and adolescents with type 1 diabetes, consistent with a study of Swedish young adults showing 13% [39].

5.3. *Gender and incidence of type 1 diabetes*

The observed small gender differences in incidence of type 1 diabetes were restricted to some pediatric subgroups, but for the whole population 0–100 years, and also for 0–19 years and 20–100 years, there were no gender differences, consistent with international findings [1]. None or minor male excess has been identified in previous studies in Europe and populations of European origin, and a female excess in populations of African and Asian origin [40]. The gender distribution in the older age groups has not been described previously [41].

5.4. *Incidence of type 2 diabetes*

Incidence studies of type 2 are few, probably due to the difficulty in defining time of onset [2] but also a greater number of patients and more diverse health care systems. Covering all ages and a high level of casefinding may have contributed to the high incidence of type 2 in adults found in Kronoberg compared to earlier reports from Sweden [7,9,10]. For case-finding the method of opportunistic screening was used, which has been shown to be an effective tool to catch patients with non-symptomatic diabetes mellitus within primary health care [13,14]. Consistently applied it is estimated to screen half of a total population within one year, and 85–90% within 4–5 years. This screening method was probably one important explanation of the good coverage and level of incidences in our study. In the town of Laxa, Sweden 1972–1987 the mean incidence of type 2 was 331, in ages 35–79 years, and was recently reported not to have increased [7,42]; in Skaraborg, Sweden, 1991–1995 it was 266, all ages [10]. Earlier incidence studies used clinical classification [6–8,10], which if any ought to have the effect of underestimating the proportion of type 1 and slightly increase the amount of type 2. The age distribution of the Swedish population with many elders renders higher incidences of type 2 compared to standardization to the world population (Table 1).

The incidence of type 2 increased with age, as previously shown [8,43]. In Cremona, Italy the incidence was estimated as neglible below age 30 years and 600 for ages above 50 years 1988–1994, comparable to Kronoberg [8]. The Framingham Heart Study, Massachusetts, USA showed a much higher incidence of type 2 than we found, with a doubling over the past 30 years, for women from 2000 to 3700, for men from 2700 to 5800 [44]. A British records study of a 1.3 million population, found an incidence of all diabetes of 221, which was a 25% increase from 1994 to 1998 concluding it an actual increase in incidence and neither due to the increase of elders in the population nor to better screening [46]. From Finland an alarming increase in the incidence of type 2 diabetes in young adults was recently reported to have occurred during the 1990's, reporting figures not so different from Kronoberg if time of registration, reported yearly increase, and amount of unclassified diabetes, are considered, and similarly increasing with age [34].

Several countries report many undiagnosed cases of type 2 diabetes [11]. One very large Norwegian diabetes prevalence screening study found 20% previously undiagnosed diabetes [45]. With high levels of availability and resources of care in the Swedish health care system and using the method of opportunistic screening we expect fewer undiagnosed cases than previously reported from other parts of the world [11,13,14], at the most in level with the mentioned Norwegian study. A Dutch study found a low yield of population-based screening and recommended opportunistic screening [47].

5.5. *Gender and incidence of type 2 diabetes*

In adults in Kronoberg men predominated among incident cases of type 2, similar to, among others, studies from Norway and the United States from the last part of the 20th century [41].

5.6. *Type 2 diabetes in children and adolescents*

Type 2 did occur in children in Kronoberg but in very few cases and only among the 10–14- year-olds, in contrast to reports of increasing prevalence of type 2 in adolescents worldwide [48]. In Tokyo, Japan, a study of 8.8 million school children 1974–2002 found an incidence of type 2 of 2.6, among junior high school students 6.4, similar to Kronoberg [49].

6. Conclusions

Onset of type 1 diabetes was not restricted to children and young adults since all ages above 50 years had an incidence as high as the children. New onset antibody positive type 1 was found in all ages. In absolute numbers nearly 60% of new type 1 diabetes cases were diagnosed above age 40 years. The incidences we found of type 1 diabetes in both children and adults in Kronoberg were among the highest reported.

The frequency of type 2 diabetes among young teenagers was low. The incidence of type 2 diabetes in adults in Kronoberg was higher than previously reported from Sweden. New diagnostic criteria, a high level of case-finding, and many elders in the population may have contributed to the results, but they may also reflect a true increase in incidence of both types of diabetes.

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Conflict of interest

There are no conflicts of interest.

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