

# Age of Onset and Type of Diabetes

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The age of onset and the clinical type of diabetes mellitus were evaluated on the basis of a cross-sectional study of medical records of 14 municipal health centers in East Finland. Altogether 281 patients were classified as having insulin-dependent (IDDM) and 2713 as having non-insulin-dependent (NIDDM) diabetes. Nearly all patients diagnosed before the age of 19 had IDDM, but a large proportion (37%) of all diagnoses of IDDM were made after that age. Six percent of all diabetic subjects in the age group 15–19 yr were classified as NIDDM and the proportion increased rapidly in older age groups. Half of the patients with NIDDM were diagnosed over the age of 64. *DIABETES CARE* 1985; 8:114–17.

Very little is known about the occurrence of insulin-dependent diabetes mellitus (IDDM) in older and non-insulin-dependent diabetes mellitus (NIDDM) in younger age groups.<sup>1</sup> This is evidently caused by difficulties in collecting relevant data with good ascertainment in whole populations. As far as we know the only population-based study of this kind is that of Melton et al.<sup>2</sup> on the incidence of IDDM and NIDDM in the population of Rochester, Minnesota.

The aim of this study was to examine age relationships of IDDM and NIDDM in a cross-sectional study based on medical records of 14 municipal health centers in East Finland.

## STUDY POPULATION AND METHODS

The Kuopio University Central Hospital district comprises a population of 250,000 inhabitants. In this district, as in all of Finland, the municipal health center is a functional unit providing basic health services for the population, including diabetes care. There are 23 such health centers in the Kuopio University Central Hospital district. Hospital services, including all main clinical specialties, are also provided by municipalities, and in the Kuopio University Hospital district this is done at the university hospital and three other small hospitals. Only a small number of physicians are in private practice, and in the Kuopio University Central Hospital district almost all of them have their practice in the town of Kuopio.

All medical records of living patients of 14 health centers, covering a total population of 151,000 inhabitants (13 rural health centers, population base of 77,000; the Kuopio town

health center, population base of 74,000), were analyzed to identify persons with a diagnosis of diabetes up to 1981. The population living in the municipalities served by these 14 health centers was representative of the whole population of the Kuopio University Central Hospital district with respect to age and sex structure and other relevant demographic characteristics.

The WHO diagnostic criteria for diabetes mellitus were applied.<sup>3</sup> A person was classified as having diabetes if the fasting blood glucose concentration was at least 127 mg/dl on more than one occasion and/or the 2-h blood glucose concentration was at least 180 mg/dl (venous whole blood).

To classify diabetes according to type, the following criteria were applied: IDDM: (1) a person of any age treated initially and thereafter with insulin and (2) ketonuria or ketoacidosis at the time of diagnosis; NIDDM: (1) a person of any age treated initially with diet and/or oral drugs and thereafter with diet only, oral drugs, or insulin (insulin treatment permitted 1 yr or more after the diagnosis) and (2) no ketonuria or ketoacidosis at the time of diagnosis or later.

The degree of ascertainment of diabetic patients in this study was evaluated on the basis of a national register of drug-treated diabetic patients. All diabetic patients in Finland needing drug therapy are provided with medication free of charge according to the Sickness Insurance Act. The Social Insurance Institution maintains a central register of diabetic persons receiving drug reimbursement. In the 13 rural health centers 95% of the diabetic persons identified as treated with drug therapy on the basis of the national register were found. In the town of Kuopio the corresponding figure was only 64% due to a greater proportion of diabetic persons under the care

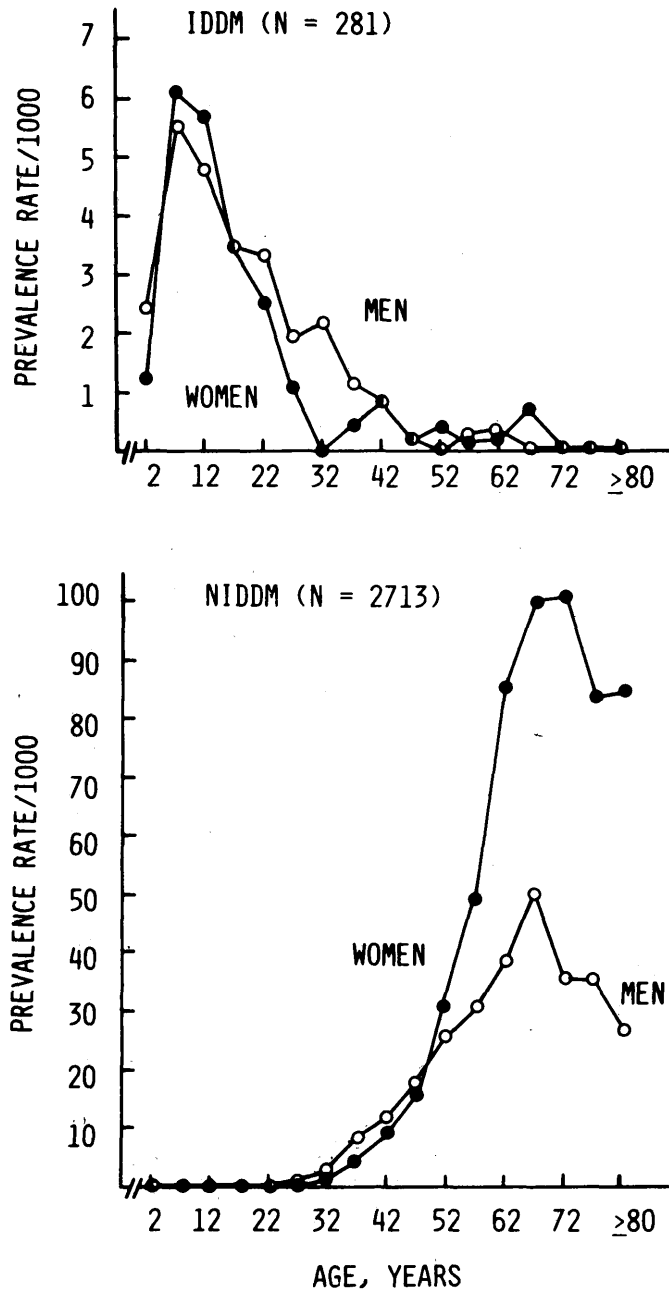


FIG. 1. Prevalence rate of insulin-dependent and non-insulin-dependent types of diabetes by age at diagnosis (5-yr age groups) and by sex.

of private physicians. When the proportions of IDDM and NIDDM in different age groups of the Kuopio town diabetic population identified through the municipal health center records were compared with the corresponding proportions in the diabetic population of those 13 rural health centers in which the degree of ascertainment was high, it became evident that these proportions were almost identical. Therefore, it is unlikely that the lower degree of ascertainment of diabetic patients in the Kuopio town would have distorted the relative

proportion of IDDM and NIDDM in different age groups of the whole population on which this study is based.

Altogether 3389 persons with a diagnosis of diabetes were identified (1101 men, 2288 women) on the basis of medical records of 14 health centers; 281 patients were classified as insulin-dependent (154 men, 127 women) and 2713 as non-insulin-dependent (823 men, 1890 women). Of this number 395 were excluded from further analyses: 328 due to incomplete information (97 men, 231 women); 19 patients due to secondary diabetes (12 men, 7 women), and 48 unclassifiable patients (15 men, 33 women) (patients initially treated with diet and/or oral drugs but insulin therapy started before 1 yr after the diagnosis).

## RESULTS

The age at diagnosis and sex distribution of patients with IDDM and NIDDM are presented in Figure 1. The age of onset of IDDM varied greatly, but for the most part (63%) the diagnosis was made for both sexes before age 19. The peak prevalence for men and women was in the age group 5–9 yr. The age of onset seemed to occur somewhat later in men, although in age groups over 39 there was no sex difference. NIDDM was rare before age 19, and practically all diabetic persons before that age belonged to the IDDM group. In contrast to IDDM, NIDDM seemed to occur somewhat earlier for men than for women. The peak prevalence for men occurred at 65–69 yr and for women at 70–74 yr. Over age 64 practically all newly diagnosed diabetic subjects belonged to the NIDDM group. There was no sex difference in the prevalence of NIDDM under age 54, but in older ages NIDDM was much more common among women.

Figure 2 shows the percentage proportions of IDDM and NIDDM at the time of diagnosis. Although nearly all diabetic persons diagnosed before age 19 had IDDM, a very marked proportion (37%) of all diagnoses of IDDM was made after

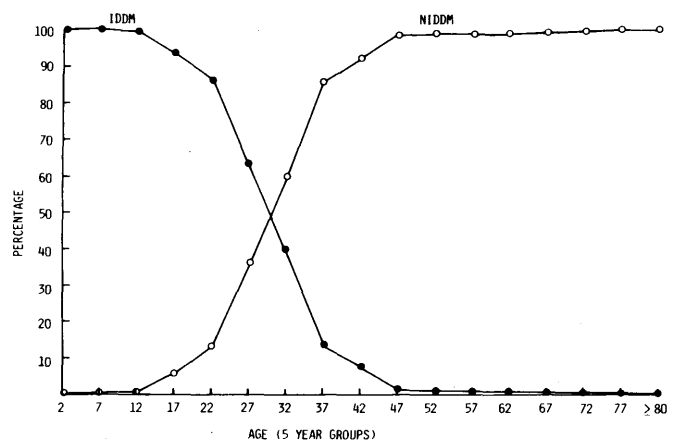


FIG. 2. Percentage of diabetic persons classified into the insulin-dependent and non-insulin-dependent types of diabetes by age at diagnosis (5-yr age groups).

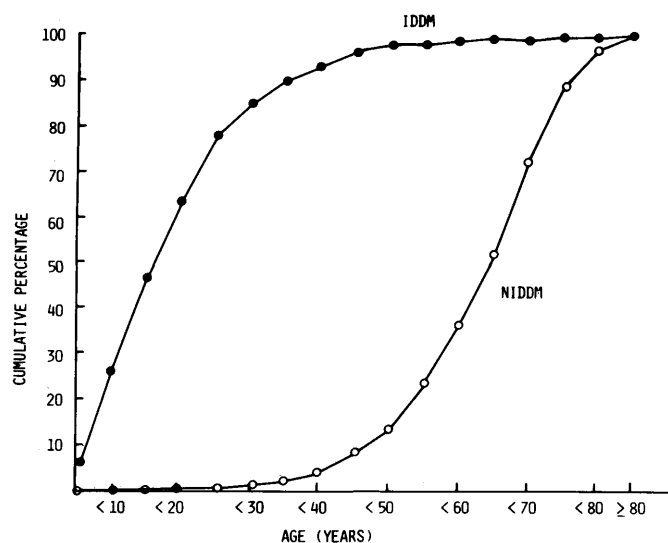


FIG. 3. The cumulative percentage of diabetic persons in insulin-dependent and non-insulin-dependent categories by increasing attained age at diagnosis.

that age. IDDM was rare over age 55, with only 4% of all diabetic subjects diagnosed after that age classified as IDDM. Six percent of all diabetic patients in the age group 15–19 were classified as non-insulin-dependent and the proportion increased rapidly in older age groups. NIDDM was relatively rare before age 40, and only 3% of all NIDDM diagnoses was made in younger age groups. In the group 30–34 yr the relative frequency of NIDDM exceeded that of IDDM (60% and 40%, respectively). Half of the patients with NIDDM were diagnosed over age 64.

Figure 3 shows the cumulative percentage of persons with

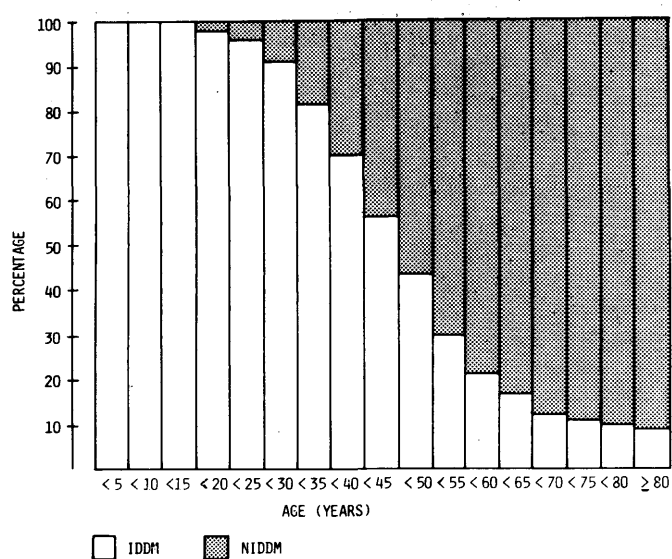


FIG. 4. The percentage proportions of insulin-dependent and non-insulin-dependent types of diabetes by increasing attained age at diagnosis.

IDDM and NIDDM by age. The cumulative proportion of IDDM was 84% at 30 yr and 95% at 50 yr. The cumulative proportion of NIDDM was 0.4% at age 30, 14% at 50, and 73% at 70.

Figure 4 summarizes the proportion of IDDM and NIDDM in relation to attained age at diagnosis. Below 20 yr nearly all diabetic persons were insulin-dependent. At age 50 the relative proportion of NIDDM exceeded that of IDDM (57% and 43%, respectively). In the whole study population the relative proportions of IDDM and NIDDM were 9.4% and 90.6%, respectively.

Insulin-treated diabetes was much more common than IDDM in the population studied, as shown in Table 1. Insulin treatment under age 14 equaled the relative proportion of insulin-dependent diabetes. Above age 45 the relative proportion of diabetic subjects classified as insulin-dependent became small, but still more than one-tenth of the diabetic subjects were receiving insulin treatment. No sex difference was observed in the population of diabetic subjects receiving insulin treatment in different age groups.

#### DISCUSSION

In the present study ascertainment of diabetic patients belonging to the populations living in the 14 study municipalities in the Kuopio University Central Hospital district was based on the medical records of municipal health centers. Due to the central role of those health centers in the care of diabetic patients, the degree of ascertainment was high, as shown by comparison with the independent data from the Finnish Social Insurance Institution's register of people receiving drugs for the treatment of diabetes. The number of diabetic patients being treated by private physicians was negligible in the 13 rural municipalities, but about 35% in Kuopio town, leading to a corresponding underascertainment in this municipality. The average degree of ascertainment for the whole study population, weighted by the size of populations of municipalities, was 80%. Altogether 12% of the diabetic subjects had to be excluded from the analyses concerning type of diabetes due to incomplete data on diabetes diagnosis or impossibility of classification on the basis of available data. Due to the underascertainment and exclusions specified above,

TABLE 1

The proportion of IDDM and insulin-treated diabetic subjects (%) among all diabetic subjects by age and sex

Age (yr)	Men		Women	
	IDDM	Insulin treatment	IDDM	Insulin treatment
0–14	100	100	100	100
15–34	67	83	70	85
35–44	11	43	9	42
45–54	2	20	1	16
55–64	1	10	0	14
≥65	1	10	0	11

the prevalence rates calculated for the two types of diabetes (IDDM: 0.19%, NIDDM: 1.79%) are slightly below the true prevalence rates (IDDM: 0.20%, NIDDM: 2.14%; estimate based on 13 rural health centers' medical records where the degree of ascertainment was 95%). However, it is unlikely that underascertainment and exclusions would have distorted the relative proportion of IDDM and NIDDM in different age groups of the whole population because the proportion of two main types of diabetes was actually similar in the town of Kuopio and in 13 rural municipalities.

The criteria for insulin dependence in this study were ketonuria/ketoacidosis at the time of diagnosis and the use of insulin in the treatment of diabetic subjects. These criteria for IDDM are strict, and it is unlikely that our data contain "false positive" insulin-dependent diabetic persons. The criteria for NIDDM were the absence of ketonuria or ketoacidosis at the time of diagnosis or later and treatment with diet and/or oral drugs (insulin treatment permitted 1 yr or more after the diagnosis). However, it is difficult to differentiate patients who were NIDDM and treated with insulin from those patients who might have had slowly developing IDDM. Plasma C-peptide response after glucagon stimulation has been suggested to be of clinical value in making the distinction between IDDM and NIDDM among insulin-treated diabetic subjects,<sup>4,5</sup> but this test was not used in the time period on which the present study is based.

The results concerning the occurrence of IDDM in the region of the Kuopio University Central Hospital in different age groups resembled those published previously for the whole country on the basis of the national drug register.<sup>6</sup> In younger age groups the age of onset was somewhat later in men than in women. In turn, NIDDM appeared earlier in men. NIDDM was much more common in women, which is partly explained by the later occurrence of this type of diabetes in women and apparently also by selective mortality of men from cardiovascular causes in older age groups. IDDM was very rare in both sexes after age 44. This low prevalence figure may be also partly due to a high age-specific mortality rate of insulin-dependent diabetes in older age groups.

In the study of Melton et al.<sup>2</sup> concerning the incidence of diabetes by clinical type in different age groups in the population of Rochester, Minnesota, based on 1135 diabetic patients, the relative proportion of IDDM and NIDDM under age 30 differed significantly from results reported in this study. In their study of patients <30 yr at diagnosis, only 58% were in the IDDM group whereas in our study the corresponding proportion was 92%. Contradictory results may be explained by different criteria used in the definition of diabetes, by sample size, by different clinical practice, but also by real differences in the populations studied. In our study, the WHO criteria for diabetes were applied, but Melton et al.<sup>2</sup> used slightly lower blood glucose values to diagnose diabetes, which may increase the proportion of NIDDM. In the study by Melton et al. only 75 insulin-dependent diabetic subjects were included, whereas in our study the corresponding number was 281. The small sample of Melton et al. may distort the relative proportion of IDDM and NIDDM groups. Real differences

between populations studied are not excluded, however. Finland has the highest reported prevalence and incidence of IDDM in young age groups.<sup>6</sup> In addition, IDDM is more common in East Finland than in other parts of the country,<sup>6</sup> which may even increase the relative proportion of IDDM in younger age groups.

Insulin-dependent diabetes also occurs in a marked proportion in older age groups, as shown in the study of Melton et al.<sup>2</sup> and in the present study. In the study of Melton et al. 32% of all IDDM patients were over 30 yr at the time of diagnosis. In our study the corresponding proportion was 15%.

Melton et al. divided insulin-treated diabetic subjects into obese (relative weight 1.4 or more) and nonobese groups, two-thirds of them belonging to the obese group. The data concerning weight in middle-aged and elderly patients were often incomplete in the medical records of the present study so that a distinction between obese and nonobese non-insulin-dependent diabetic subjects could not be made. However, on the basis of a later study of middle-aged diabetic subjects from the same region,<sup>7</sup> the proportion of obese diabetic patients was about the same in the NIDDM group as that reported by Melton et al.

In conclusion, the results of the present study further support the view that the separation of diabetic subjects into "juvenile-onset" or "maturity-onset" type according to age at diagnosis (e.g., age below 30 yr) is imprecise because IDDM may occur at any age and because NIDDM may also occur among young people. There may be significant differences between populations in the relative proportion of IDDM and NIDDM in relation to age and, therefore, further population-based studies are needed.

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