

Supplementary Methods

Data sources

NDR is a quality registry in Sweden founded in 1996, which was initiated as a tool for clinics to compare various medical results and nationwide goals set for DM. It is now an established generator for quality control and systemic works of improvement in the field of DM.(1) This registry prospectively assembles information regarding risk factors, complications of DM and medications. Data is entered manually by the clinics, in a web-based manner, each patient visit is encouraged to be reported by the clinics. Clinical information from all centers is anonymously extracted and centrally analyzed. The data reported in the NDR corresponds to a coverage of >90% of all T1DM patients in Sweden.(2)

Information regarding comorbidities and diagnoses during follow up were retrieved from the Swedish in-Patient Registry(3), while death and cause of death were provided through Cause of Death Registry(4) and all prescriptions including ATC codes filled at all pharmacies since 2005 from the Swedish Prescribed Drug Register (SPDR).(5) Diagnoses are classified according to the International Classification of Diseases (ICD-10). Data linkage between registries is nearly complete due to Sweden's unique personal identification number, received at birth or time of immigration.

Kidney function assessment

The KDIGO categories are defined as follows: G1 - eGFR ≥ 90 , G2 - eGFR 60–89, G3 - eGFR 30–59, G4 - eGFR 15–29, and G5 - eGFR < 15 ml/min/1.73m² (Table S1). The G1 category is further divided into G1a (eGFR 90–104 ml/min/1.73m²) and G1b (eGFR ≥ 105 ml/min/1.73m²). Similarly, the G3 category is subdivided into G3a (eGFR 45–59 ml/min/1.73m²) and G3b (eGFR 30–44 ml/min/1.73m²). Albuminuria is categorized as A1 for normoalbuminuria (urine albumin/creatinine ratio, UACR < 30 mg/g), A2 for microalbuminuria (UACR 30–300 mg/g), and A3 for macroalbuminuria (UACR > 300 mg/g).

Supplementary tables

Table S1 | KDIGO GFR and albuminuria categories

Prognosis of CKD by GFR and albuminuria categories: KDIGO 2012				Persistent albuminuria categories, description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30–300 mg/g 3–30 mg/mmol	>300 mg/g >30 mg/mmol
GFR categories (ml/min/1.73 m ²), description and range	G1	Normal or high	≥90			
	G2	Mildly decreased	60–89			
	G3a	Mildly to moderately decreased	45–59			
	G3b	Moderately to severely decreased	30–44			
	G4	Severely decreased	15–29			
	G5	Kidney failure	<15			

green, low risk (if no other markers of kidney disease, no CKD); yellow, moderately increased risk; orange, high risk; red, very high risk.

Used with permission from *KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease*.⁽⁶⁾

Table S2 | ICD Codes reference

Outcomes	ICD codes
Kidney	
Kidney Failure	N185, Z490, Z491, Z492, Z99.2, DR012, DR013, DR014, DR015, DR016, DR023, DR024, DR055, DR056
Acute Kidney Injury	N17.0, N17.1, N17.2, N17.8, DR015 and DR023 (only if without N18 or N19.9)
Cardiovascular	
Coronary heart disease	I20, I21, I22, I23, I24, I25
Heart Failure	I50
Stroke	I61, I62, I63, I64
Mortality	
All-cause	All with a death date
Renal death	Any death occurring within four weeks after MAKE
Cardiovascular	Any death due to coronary heart disease or stroke
Cancer	C0, C1, C2, C3, C4, C5, C6, C7, C8, C9

Table S3 | Baseline characteristics according to categorized variables

H							
	G1a	G1b	G2	G3a	G3b	G4	Total
	N=22 850	N=8169	N=6051	N=1043	N=617	N=337	N=39 067
Female	9554 (41.8%)	3596 (44.0%)	3257 (53.8%)	584 (56.0%)	327 (53.0%)	170 (50.4%)	17 488(44.8%)
Age categories (years)							
18–34	17 853 (78.1%)	2559 (31.3%)	943 (15.6%)	70(6.7%)	24 (3.9%)	15 (4.5%)	21 464(54.9%)
35–49	4485 (19.6%)	2692 (33.0%)	2001 (33.1%)	247 (23.7%)	190 (30.8%)	117 (34.7%)	9732(24.9%)
50–59	472(2.1%)	1928 (23.6%)	1475 (24.4%)	242 (23.2%)	159 (25.8%)	96 (28.5%)	4372(11.2%)
60–69	38(0.2%)	906 (11.1%)	1159 (19.2%)	309 (29.6%)	148 (24.0%)	79 (23.4%)	2639(6.8%)
70+	2(0.0%)	84(1.0%)	473 (7.8%)	175 (16.8%)	96 (15.6%)	30 (8.9%)	860(2.2%)
Duration of diabetes in categories (years)							
[0–5]	5604 (24.5%)	642 (7.9%)	169 (2.8%)	8(0.8%)	3(0.5%)	2(0.6%)	6428(16.5%)
(5–10]	4721 (20.7%)	618 (7.6%)	196 (3.2%)	11(1.1%)	6(1.0%)	2(0.6%)	5554(14.2%)
(10–15]	4476 (19.6%)	757 (9.3%)	313 (5.2%)	16(1.5%)	5(0.8%)	3(0.9%)	5570(14.3%)
(15–20]	3220 (14.1%)	842 (10.3%)	411 (6.8%)	38(3.6%)	26 (4.2%)	13 (3.9%)	4550(11.6%)
(20–25]	1984 (8.7%)	893 (10.9%)	557 (9.2%)	61(5.8%)	34 (5.5%)	26 (7.7%)	3555(9.1%)
(25–30]	1340 (5.9%)	1011 (12.4%)	721 (11.9%)	84(8.1%)	68 (11.0%)	35 (10.4%)	3259(8.3%)
(30–35]	822 (3.6%)	972 (11.9%)	797 (13.2%)	116 (11.1%)	78 (12.6%)	47 (13.9%)	2832(7.2%)
35+	683 (3.0%)	2434 (29.8%)	2887 (47.7%)	709 (68.0%)	397 (64.3%)	209 (62.0%)	7319(18.7%)
HbA1c categories (mmol/mol)							
<48	2700 (11.8%)	906 (11.1%)	611 (10.1%)	72 (6.9%)	49 (7.9%)	38 (11.3%)	4376 (11.2%)
48–52	1606 (7.0%)	664 (8.1%)	513 (8.5%)	72 (6.9%)	53 (8.6%)	25 (7.4%)	2933 (7.5%)
52–57	2690 (11.8%)	1184 (14.5%)	908 (15.0%)	129 (12.4%)	73 (11.8%)	42 (12.5%)	5026(12.9%)
57–70	7319 (32.0%)	3102 (38.0%)	2235 (36.9%)	385 (36.9%)	198 (32.1%)	116 (34.4%)	13355(34.2%)
70+	8109 (35.5%)	2181 (26.7%)	1686 (27.9%)	363 (34.8%)	230 (37.3%)	107 (31.8%)	12676(32.4%)
Missing	426(1.9%)	132 (1.6%)	98 (1.6%)	22(2.1%)	14 (2.3%)	9(2.7%)	701(1.8%)
Systolic blood pressure categories (mmHg)							
<110	2641 (11.6%)	557 (6.8%)	309 (5.1%)	32(3.1%)	29 (4.7%)	8(2.4%)	3576(9.2%)
110–119	5575 (24.4%)	1251 (15.3%)	740 (12.2%)	75(7.2%)	30 (4.9%)	30 (8.9%)	7701(19.7%)
120–129	7184 (31.4%)	2326 (28.5%)	1476 (24.4%)	212 (20.3%)	107 (17.3%)	59 (17.5%)	11 364(29.1%)

130–139	3680 (16.1%)	1789 (21.9%)	1391 (23.0%)	234 (22.4%)	133 (21.6%)	60 (17.8%)	7287(18.7%)
140–149	1363 (6.0%)	1044 (12.8%)	957 (15.8%)	198 (19.0%)	120 (19.4%)	69 (20.5%)	3751(9.6%)
150–159	405(1.8%)	455 (5.6%)	455 (7.5%)	114 (10.9%)	71 (11.5%)	42 (12.5%)	1542(3.9%)
160+	285(1.2%)	374 (4.6%)	462 (7.6%)	130 (12.5%)	97 (15.7%)	55 (16.3%)	1403(3.6%)
Diastolic blood pressure categories (mmHg)							
<60	585(2.6%)	183 (2.2%)	193 (3.2%)	50(4.8%)	31 (5.0%)	16 (4.7%)	1058(2.7%)
60–69	4990 (21.8%)	1666 (20.4%)	1304 (21.6%)	260 (24.9%)	135 (21.9%)	67 (19.9%)	8422(21.6%)
70–79	8822 (38.6%)	3250 (39.8%)	2333 (38.6%)	377 (36.1%)	207 (33.5%)	115 (34.1%)	15 104 (38.7%)
80–89	5703 (25.0%)	2261 (27.7%)	1662 (27.5%)	233 (22.3%)	167 (27.1%)	93 (27.6%)	10119 (25.9%)
90–99	838 (3.7%)	352 (4.3%)	238 (3.9%)	54 (5.2%)	30 (4.9%)	21 (6.2%)	1533 (3.9%)
100–109	117 (0.5%)	52 (0.6%)	43 (0.7%)	16 (1.5%)	12 (1.9%)	5 (1.5%)	245 (0.6%)
110+	9 (0.0%)	6 (0.1%)	3 (0.0%)	0 (0.0%)	2 (0.3%)	6 (1.8%)	26 (0.1%)
BMI categories							
< 18.5	437 (1.9%)	60 (0.7%)	58 (1.0%)	10 (1.0%)	9 (1.5%)	7 (2.1%)	581 (1.5%)
19–25	10187 (44.6%)	3381 (41.4%)	2342 (38.7%)	378 (36.2%)	221 (35.8%)	140 (41.5%)	16649 (42.6%)
25–30	5742 (25.1%)	2702 (33.1%)	2014 (33.3%)	307 (29.4%)	160 (25.9%)	86 (25.5%)	11011 (28.2%)
30–35	1650 (7.2%)	716 (8.8%)	600 (9.9%)	138 (13.2%)	78 (12.6%)	33 (9.8%)	3215 (8.2%)
35–40	453 (2.0%)	153 (1.9%)	154 (2.5%)	35 (3.4%)	34 (5.5%)	17 (5.0%)	846 (2.2%)
40+	185 (0.8%)	47 (0.6%)	43 (0.7%)	10 (1.0%)	8 (1.3%)	4 (1.2%)	297 (0.8%)
Missing	4196 (18.4%)	1110 (13.6%)	840 (13.9%)	165 (15.8%)	107 (17.3%)	50 (14.8%)	6468 (16.6%)

G1a: eGFR 105+, G1b: eGFR 90–104, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29 ml/min/1.73m², BMI: Body Mass Index

Table S4a | Unadjusted hazard ratios for major outcomes with conventional G1A1+G2A1 categories as reference

		A1	A2	A3
G1	40 % decline	1	5.18 (4.00-6.72)	17.48 (13.08-23.35)
	KF	1	3.72 (2.52-5.49)	17.39 (11.83-25.58)
	MAKE	1	3.98 (3.11-5.09)	14.69 (11.22-19.24)
	MACE	1	1.85 (1.65-2.07)	2.27 (1.85-2.78)
	Mortality	1	1.9 (1.64-2.21)	2.56 (1.97-3.31)
G2	40% decline	1	12.24 (9.46-15.85)	28.37 (22.11-36.41)
	KF	1	11.37 (8.01-16.13)	52.23 (39.23-69.55)
	MAKE	1	9.87 (7.76-12.54)	28.78 (23.00-36.01)
	MACE	1	4.80 (4.30-5.36)	7.00 (6.12-8.02)
	Mortality	1	5.10 (4.44-5.86)	7.64 (6.47-9.03)
G3a	40% decline	10.39 (6.90-15.65)	14.41 (9.57-21.70)	51.62 (40.19-66.31)
	KF	25.14 (16.79-37.63)	33.56 (22.18-50.76)	146.04 (111.72-190.90)
	MAKE	14.30 (10.30-19.85)	19.25 (13.74-27.00)	71.56 (57.82-88.55)
	MACE	7.88 (6.77-9.17)	8.24 (6.92-9.82)	9.29 (7.86-10.99)
	Mortality	10.02 (8.44-11.89)	11.32 (9.35-13.70)	11.42 (9.43-13.83)
G3b	40% decline	7.51 (3.09-18.25)	25.57 (16.45-39.75)	82.00 (65.86-102.10)
	KF	57.98 (33.68-99.81)	133.44 (93.77-189.89)	308.02 (241.57-392.74)
	MAKE	25.77 (15.53-42.75)	59.51 (43.62-81.17)	138.88 (115.11-167.56)
	MACE	11.05 (8.37-14.58)	11.38 (8.93-14.49)	13.93 (11.89-16.32)
	Mortality	17.07 (13.02-22.37)	13.86 (10.69-17.96)	16.73 (14.11-19.83)
G4	40% decline	12.01 (2.98-48.35)	35.63 (4.87-67.27)	57.30 (43.94-74.72)
	KF	202.76 (105.74-388.80)	366.61 (237.76-565.29)	727.90 (569.34-930.64)
	MAKE	82.71 (43.90-155.79)	150.74 (100.47-266.18)	327.89 (270.41-397.58)
	MACE	14.69 (8.51-25.35)	18.72 (12.71-27.57)	20.69 (17.27-24.79)
	Mortality	14.20 (7.37-27.36)	27.30 (18.99-39.23)	27.78 (23.26-33.18)

G1: eGFR ≥90, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29, G5: eGFR < 15 ml/min/1.73 m²
A1: urine albumin/creatinine ratio (UACR) <30mg/g, A2: UACR 30–300 mg/g, A3: UACR >300 mg/g, KF: Kidney failure, MAKE: Major adverse kidney event, MACE: Major adverse cardiovascular event

Table S4b | Unadjusted hazard ratios for major outcomes with G1A1 alone as reference

		A1	A2	A3
G1	40% decline	1	6.36 (4.83-8.38)	21.47 (15.84-29.10)
	KF	1	5.78 (3.76-8.90)	27.07 (17.64-41.43)
	MAKE	1	5.24 (4.02-6.83)	19.35 (14.53-25.78)
	MACE	1	2.65 (2.35-2.98)	3.24 (2.63-4.00)
	Mortality	1	2.76 (2.36-3.23)	3.71 (2.85-4.83)
G2	40% decline	2.62 (1.93-3.57)	15.04 (11.43-19.79)	34.85 (26.72-45.47)
	KF	4.29 (2.89-6.38)	17.67 (11.90-26.23)	81.15 (57.76-114.02)
	MAKE	2.90 (2.23-3.78)	13.00 (10.04-16.84)	37.89 (29.69-48.37)
	MACE	3.58 (3.28-3.90)	6.88 (6.13-7.72)	10.00 (8.69-11.51)
	Mortality	3.72 (3.31-4.18)	7.40 (6.38-8.58)	11.07 (9.31-13.17)
G3a	40% decline	12.76 (8.39-19.42)	17.70 (11.63-26.93)	63.41 (48.56-82.81)
	KF	39.06 (25.07-60.84)	52.14 (33.15-81.99)	226.77 (163.90-313.75)
	MAKE	18.83 (13.37-26.51)	25.34 (17.82-36.04)	94.15 (74.50-118.99)
	MACE	11.23 (9.61-13.13)	11-76 (9.84-14.07)	13.23 (11.14-15.71)
	Mortality	14.50 (12.13-17.34)	16.39 (13.46-19.96)	16.51 (13.54-20.12)
G3b	40% decline	9.23 (3.78-22.52)	31.41 (20.02-49.30)	100.73 (79.40-127.79)
	KF	90.01 (50.74-159.70)	207.10 (139.16-308.22)	477.82 (352.43-647.82)
	MAKE	33.90 (20.25-56.77)	78.27 (56.54-108.36)	182.56 (147.80-225.48)
	MACE	15.70 (11.87-20.78)	16.13 (12.63-20.59)	19.71 (16.76-23.19)
	Mortality	24.66 (18.73-32.46)	20.01 (15.37-26.07)	24.12 (20.21-28.79)
G4	40% decline	14.75 (3.65-59.57)	43.76 (23.02-83.19)	70.38 (53.13-93.23)
	KF	314.45 (159.89-618.42)	568.65 (355.32-910.05)	1128.75 (830.76-1533.63)
	MAKE	108.70 (57.28-206.26)	198.13 (130.55-300.68)	430.79 (347.24-534.45)
	MACE	20.74 (12.01-35.84)	26.44 (17.92-39.00)	29.23 (24.31-35.14)
	Mortality	20.44 (10.59-39.46)	39.33 (27.28-56.72)	39.98 (33.26-48.06)

G1: eGFR ≥ 90 , G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29, G5: eGFR < 15 ml/min/1.73 m² A1: urine albumin/creatinine ratio (UACR) < 30 mg/g, A2: UACR 30–300 mg/g, A3: UACR > 300 mg/g, KF: Kidney failure, MAKE: Major adverse kidney event, MACE: Major adverse cardiovascular event

Supplementary figure titles and legends:

Figure S1

Flow diagram of participant selection

Legend: NDR: National Diabetes Register,

G1a: eGFR ≥ 105 , G1b: eGFR 90–104, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29 ml/min/1.73m². KF; Kidney failure = G5 (eGFR <15 ml/min/1.73m²)

Figure S2

Cumulative incidence of renal outcomes using Kaplan-Meier survival plots

- a. 40% eGFR decline
- b. Acute kidney injury
- c. Kidney Failure
- d. MAKE
- e. Renal death

Legend: G1a: eGFR ≥ 105 , G1b: eGFR 90–104, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29 ml/min/1.73m²

Figure S3

Cumulative incidence of CV outcomes using Kaplan-Meier survival plots

- a. Coronary heart disease
- b. Stroke
- c. Cardiovascular death
- d. MACE
- e. Heart Failure

Legend: G1a: eGFR ≥ 105 , G1b: eGFR 90–104, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29 ml/min/1.73m²

Figure S4

Cumulative incidence of all-cause mortality using Kaplan-Meier survival plots

Legend: G1a: eGFR ≥ 105 , G1b: eGFR 90–104, G2: eGFR 60–89, G3a: eGFR 45–59, G3b: eGFR 30–44, G4: eGFR 15–29 ml/min/1.73m²

References:

1. Nationella Diabetesregistret, årsrapport 2021.
https://www.ndr.nu/pdfs/Arsrapport_NDR_2021.pdf.
2. Rawshani A, Sattar N, Franzen S, Rawshani A, Hattersley AT, Svensson AM, et al. Excess mortality and cardiovascular disease in young adults with type 1 diabetes in relation to age at onset: a nationwide, register-based cohort study. *Lancet*. 2018;392(10146):477-86.
3. Ludvigsson JF, Andersson E, Ekbom A, Feychting M, Kim JL, Reuterwall C, et al. External review and validation of the Swedish national inpatient register. *BMC Public Health*. 2011;11:450.
4. Brooke HL, Talbäck M, Hörnblad J, Johansson LA, Ludvigsson JF, Druid H, et al. The Swedish cause of death register. *Eur J Epidemiol*. 2017;32(9):765-73.
5. Eliasson B, Lyngfelt L, Strömblad SO, Franzén S, Eeg-Olofsson K. The significance of chronic kidney disease, heart failure and cardiovascular disease for mortality in type 1 diabetes: nationwide observational study. *Sci Rep*. 2022;12(1):17950.
6. Group KDIGOKCW. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. *Kidney inter, Suppl* 2013; 3: 1–150. 2012.