Supplementary Tables and Figures

Continuous Glucose Monitoring and Risks of Acute and Chronic Diabetes-related Complications and Mortality in Adults with Type 1 Diabetes: a Nationwide Cohort Study

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ESM Table 1. Baseline characteristics of the study participants before propensity score matching

	CGM non-users (*N*=44,634)	CGM users (*N*=8509)	*p* value
Index year, n (%)			<0.001
2019	29,612 (66.3)	762 (9.0)	
2020	7349 (16.5)	1336 (15.7)	
2021	5284 (11.8)	4126 (48.5)	
2022	2389 (5.4)	2285 (26.9)	
Age (years), mean ± SD	57.3 ± 17.2	42.6 ± 15.6	<0.001
Male sex, n (%)	25,452 (57.0)	3965 (46.6)	<0.001
Comorbidities, n (%)			
Hypertension	28,809 (64.5)	2965 (34.8)	<0.001
ESKD	3664 (8.2)	208 (2.4)	<0.001
CVD	6656 (14.9)	356 (4.2)	<0.001
Cancer	6461 (14.5)	854 (10.0)	<0.001
Use of lipid-lowering or antithrombotic agents, n (%)	32,856 (73.6)	4896 (57.5)	<0.001
History of acute complications, n (%)			
DKA	3593 (8.0)	1390 (16.3)	<0.001
SH	3695 (8.3)	869 (10.2)	<0.001
Newly diagnosed type 1 diabetes, n (%)	17,187 (38.5)	2256 (26.5)	<0.001
Institution, n (%)			<0.001
Primary care clinic	19,358 (43.4)	1218 (14.3)	
Secondary hospital	12,764 (28.6)	2460 (28.9)	
Tertiary hospital	12,512 (28.0)	4831 (56.8)	
Income, n (%)			<0.001
Highest 30%	14,606 (32.7)	3381 (39.7)	
Middle 40%	13,939 (31.2)	3039 (35.7)	
Lowest 30%	15,842 (35.5)	2052 (24.1)	
Unknown	247 (0.6)	37 (0.4)	

Continuous variables are presented as means ± standard deviations, and categorical variables are expressed as numbers and percentages (%).

CGM, continuous glucose monitoring; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ESKD, end-stage kidney disease; SD, standard deviation; SH, severe hypoglycaemia.

ESM Table 2. Diabetes-related complications and mortality stratified by institution type

	Tertiary hospital (*N*=7369; 2538 non-users and 4831 users)		Secondary hospital (*N*=5141; 2681 non-users and 2460 users)		Primary care clinic (*N*=4508; 3290 non-users and 1218 users)	
	Adjusted HR[a] (95% CI)	*p* value	Adjusted HR[a] (95% CI)	*p* value	Adjusted HR[a] (95% CI)	*p* value
DKA						
CGM non-users	Ref		Ref		Ref	
CGM users	0.39 (0.30, 0.51)	<0.001	0.38 (0.28, 0.51)	<0.001	0.51 (0.31, 0.83)	0.007
SH						
CGM non-users	Ref		Ref		Ref	
CGM users	0.90 (0.68, 1.19)	0.476	0.92 (0.70, 1.22)	0.579	0.85 (0.57, 1.28)	0.440
ESKD						
CGM non-users	Ref		Ref		Ref	
CGM users	0.33 (0.22, 0.49)	<0.001	0.50 (0.31, 0.81)	0.005	0.59 (0.26, 1.34)	0.206
CVD[b]						
CGM non-users	Ref		Ref		Ref	
CGM users	0.36 (0.28, 0.47)	<0.001	0.46 (0.35, 0.62)	<0.001	0.26 (0.16, 0.42)	<0.001
All-cause mortality						
CGM non-users	Ref		Ref		Ref	
CGM users	0.46 (0.34, 0.62)	<0.001	0.28 (0.18, 0.44)	<0.001	0.15 (0.07, 0.33)	<0.001

[a]Adjusted for age, sex, hypertension, ESKD, CVD, cancer, use of lipid-lowering or antithrombotic agents, and newly diagnosed type 1 diabetes
[b]Hospitalisation or ED visits

CGM, continuous glucose monitoring; CI, confidence interval; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ED, emergency department; ESKD, end-stage kidney disease; HR, hazard ratio; SH, severe hypoglycaemia.

ESM Table 3. Baseline characteristics of the age-restricted cohort (47–90 years)

	CGM non-users (*N*=3284)	CGM users (*N*=3284)	*p* value
Index year, n (%)			1.000
2019	148 (4.5)	148 (4.5)	
2020	422 (12.9)	422 (12.9)	
2021	1690 (51.5)	1690 (51.5)	
2022	1024 (31.2)	1024 (31.2)	
Age (years), mean ± SD	59.6 ± 8.8	59.2 ± 9.1	0.072
Male sex, n (%)	2038 (62.1)	1703 (51.9)	<0.001
Comorbidities, n (%)			
Hypertension	2434 (74.1)	1777 (54.1)	<0.001
ESKD	332 (10.1)	92 (2.8)	<0.001
CVD	648 (19.7)	227 (6.9)	<0.001
Cancer	670 (20.4)	649 (19.8)	0.538
Use of lipid-lowering or antithrombotic agents, n (%)	2771 (84.4)	2582 (78.6)	<0.001
History of acute complications, n (%)			
DKA	329 (10.0)	400 (12.2)	0.006
SH	292 (8.9)	415 (12.6)	<0.001
Newly diagnosed type 1 diabetes, n (%)	2427 (73.9)	1223 (37.2)	<0.001
Institution, n (%)			<0.001
Primary care clinic	1363 (41.5)	417 (12.7)	
Secondary hospital	999 (30.4)	1025 (31.2)	
Tertiary hospital	922 (28.1)	1842 (56.1)	

Continuous variables are presented as means ± standard deviations, and categorical variables are expressed as numbers and percentages (%).

CGM, continuous glucose monitoring; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ESKD, end-stage kidney disease; SD, standard deviation; SH, severe hypoglycaemia.

ESM Table 4. Characteristics of the participants according to CGM use and adherence

	CGM non-users (*N*=8509)	CGM adherence <70% (*N*=3827)	CGM adherence ≥70% (*N*=4681)	*p* value
Age (years), mean ± SD	51.6 ± 16.5	40.2 ± 14.9	44.5 ± 15.9	<0.001
Male sex, n (%)	4959 (58.3)	1686 (44.1)	2279 (48.7)	<0.001
Comorbidities, n (%)				
Hypertension	5202 (61.1)	1245 (32.5)	1720 (36.7)	<0.001
ESKD	738 (8.7)	74 (1.9)	134 (2.9)	<0.001
CVD	1343 (15.8)	149 (3.9)	207 (4.4)	<0.001
Cancer	1355 (15.9)	314 (8.2)	540 (11.5)	<0.001
Use of lipid-lowering or antithrombotic agents, n (%)	6356 (74.7)	2119 (55.4)	2777 (59.3)	<0.001
History of acute complications, n (%)				
DKA	1061 (12.5)	647 (16.9)	743 (15.9)	<0.001
SH	647 (7.6)	354 (9.3)	515 (11.0)	<0.001
Newly diagnosed type 1 diabetes, n (%)	5938 (69.8)	783 (20.5)	1472 (31.4)	<0.001
Institution, n (%)				<0.001
Primary care clinic	3290 (38.7)	573 (15.0)	645 (13.8)	
Secondary hospital	2681 (31.5)	1151 (30.1)	1309 (28.0)	
Tertiary hospital	2538 (29.8)	2103 (55.0)	2727 (58.3)	

Continuous variables are presented as means ± standard deviations, and categorical variables are expressed as numbers and percentages (%).

CGM, continuous glucose monitoring; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ED, emergency department; ESKD, end-stage kidney disease; SD, standard deviation; SH, severe hypoglycaemia.

ESM Table 5. Complications and mortality according to CGM use and adherence

	No. of participants	No. of events	Event rate[a]	Adjusted HR[b] (95% CI)	*p* value
In total population					
DKA					
CGM non-users	8509	463	35.3	Ref	
CGM adherence <70%	3827	155	23.8	0.59 (0.48, 0.73)	<0.001
CGM adherence ≥70%	4681	64	9.1	0.23 (0.18, 0.30)	<0.001
SH					
CGM non-users	8509	387	29.2	Ref	
CGM adherence <70%	3827	144	22.0	0.98 (0.79, 1.22)	0.867
CGM adherence ≥70%	4681	150	21.6	0.88 (0.71, 1.08)	0.212
ESKD					
CGM non-users	7771	217	17.6	Ref	
CGM adherence <70%	3753	35	5.4	0.40 (0.28, 0.59)	<0.001
CGM adherence ≥70%	4547	41	6.0	0.40 (0.28, 0.57)	<0.001
CVD[c]					
CGM non-users	8509	953	74.3	Ref	
CGM adherence <70%	3827	80	12.1	0.43 (0.34, 0.55)	<0.001
CGM adherence ≥70%	4681	90	12.9	0.35 (0.28, 0.44)	<0.001
All-cause mortality					
CGM non-users	8509	610	44.6	Ref	
CGM adherence <70%	3827	44	6.6	0.38 (0.27, 0.52)	<0.001
CGM adherence ≥70%	4681	65	9.2	0.36 (0.28, 0.47)	<0.001
Individuals without prior DKA, SH, or CVD[d]					
DKA					
CGM non-users	7448	224	19.2	Ref	
CGM adherence <70%	3180	65	11.7	0.59 (0.43, 0.81)	0.001
CGM adherence ≥70%	3938	27	4.5	0.23 (0.15, 0.35)	<0.001
SH					
CGM non-users	7862	276	22.2	Ref	
CGM adherence <70%	3473	93	15.5	0.94 (0.72, 1.23)	0.670
CGM adherence ≥70%	4166	86	13.8	0.75 (0.58, 0.98)	0.038
CVD[c]					
CGM non-users	7166	454	39.3	Ref	
CGM adherence <70%	3678	57	8.9	0.41 (0.31, 0.55)	<0.001
CGM adherence ≥70%	4474	61	9.0	0.33 (0.24, 0.43)	<0.001

[a]Per 1000 person-years
[b]Adjusted for age, sex, hypertension, ESKD, CVD, cancer, use of lipid-lowering or antithrombotic agents, newly diagnosed type 1 diabetes, and institution type (primary/secondary/tertiary hospital)
[c]Hospitalisation or ED visits
[d]First-event analysis

CGM, continuous glucose monitoring; CI, confidence interval; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ED, emergency department; ESKD, end-stage kidney disease; HR, hazard ratio; SH, severe hypoglycaemia.

ESM Table 6. Comparison of the frequencies of DKA, SH, and CVD-related hospitalisation or ED visits before and after CGM initiation among CGM users (*N*=5602)

	Pre-CGM use	Post-CGM use	*p* value (pre vs. post)
DKA			
No. of individuals with events	424	166	
No. of events	863	327	
Mean (± SD) frequency of events	0.15 ± 1.30	0.06 ± 0.74	<0.001
SH			
No. of individuals with events	466	222	
No. of events	748	303	
Mean (± SD) frequency of events	0.13 ± 0.57	0.05 ± 0.31	<0.001
CVD-related hospitalisation or ED visits			
No. of individuals with events	178	108	
No. of events	352	179	
Mean (± SD) frequency of events	0.06 ± 0.49	0.03 ± 0.27	<0.001

The mean (± SD) follow-up duration was identical before and after CGM initiation, at 1.9 ± 0.9 years.

CGM, continuous glucose monitoring; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ED, emergency department; SD, standard deviation; SH, severe hypoglycaemia.

ESM Table 7. Frequencies of DKA, severe hypoglycaemia, and CVD-related hospitalisation or ED visits before and after CGM initiation among CGM users, stratified by the CGM type

	rtCGM (*N*=1558)		*p* value (pre vs. post)	isCGM (*N*=3957)		*p* value (pre vs. post)
	Pre-CGM	Post-CGM		Pre-CGM	Post-CGM	
DKA						
No. of individuals with events	154	56		262	107	
No. of events	289	99		554	220	
Mean (± SD) frequency of events	0.19 ± 0.74	0.06 ± 0.46	<0.001	0.14 ± 1.47	0.06 ± 0.83	<0.001
SH						
No. of individuals with events	182	85		273	128	
No. of events	320	124		409	167	
Mean (± SD) frequency of events	0.21 ± 0.75	0.08 ± 0.37	<0.001	0.10 ± 0.47	0.04 ± 0.27	<0.001
CVD-related hospitalisation or ED visits						
No. of individuals with events	46	30		128	74	
No. of events	86	54		257	116	
Mean (± SD) frequency of events	0.06 ± 0.39	0.03 ± 0.30	<0.001	0.06 ± 0.52	0.03 ± 0.25	<0.001

The mean (± SD) follow-up duration was identical before and after CGM initiation within each CGM type: 2.6 ± 1.1 years for rtCGM and 1.6 ± 0.6 years for isCGM.

CGM, continuous glucose monitoring; DKA, diabetic ketoacidosis; ED, emergency department; isCGM, intermittently-scanned CGM; rtCGM, real-time CGM; SD, standard deviation; SH, severe hypoglycaemia.

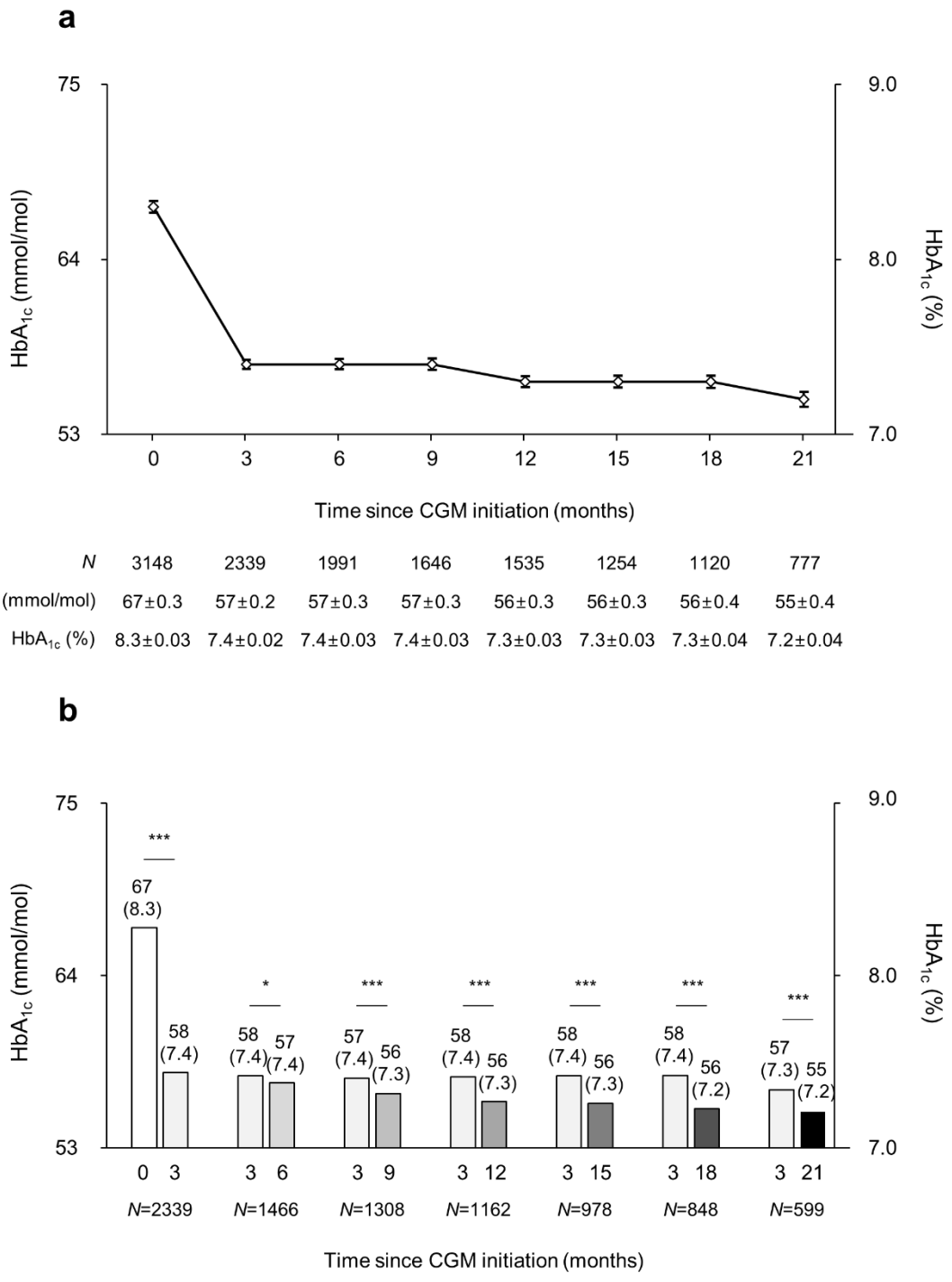
ESM Table 8. Complications and mortality of CGM users according to glycaemic status

	No. of participants	No. of events	Event rate[a]	Adjusted HR[b] (95% CI)	*p* value
In total population					
DKA					
GMI <7% or CV <36%	3690	69	10.9	Ref	
GMI ≥7% and CV ≥36%	2270	69	19.6	1.69 (1.20, 2.37)	0.003
SH					
GMI <7% or CV <36%	3690	104	16.5	Ref	
GMI ≥7% and CV ≥36%	2270	108	31.0	1.69 (1.29, 2.22)	<0.001
ESKD					
GMI <7% or CV <36%	3592	31	5.0	Ref	
GMI ≥7% and CV ≥36%	2204	27	7.8	1.21 (0.72, 2.04)	0.473
CVD[c]					
GMI <7% or CV <36%	3690	59	9.2	Ref	
GMI ≥7% and CV ≥36%	2270	66	18.7	1.53 (1.07, 2.19)	0.019
All-cause mortality					
GMI <7% or CV <36%	3690	35	5.4	Ref	
GMI ≥7% and CV ≥36%	2270	45	12.5	1.82 (1.16, 2.86)	0.009
Individuals without prior DKA, SH, or CVD[d]					
DKA					
GMI <7% or CV <36%	3364	71	12.2	Ref	
GMI ≥7% and CV ≥36%	1989	59	19.0	1.40 (0.99, 1.99)	0.060
SH					
GMI <7% or CV <36%	3141	29	5.3	Ref	
GMI ≥7% and CV ≥36%	1851	31	10.6	1.95 (1.17, 3.26)	0.011
CVD[c]					
GMI <7% or CV <36%	3556	41	6.6	Ref	
GMI ≥7% and CV ≥36%	2142	45	13.3	1.63 (1.06, 2.49)	0.026

[a]Per 1000 person-years
[b]Adjusted for age, sex, hypertension, ESKD, CVD, cancer, use of lipid-lowering or antithrombotic agents, newly diagnosed type 1 diabetes, and institution type (primary/secondary/tertiary hospital)
[c]Hospitalisation or ED visits
[d]First-event analysis

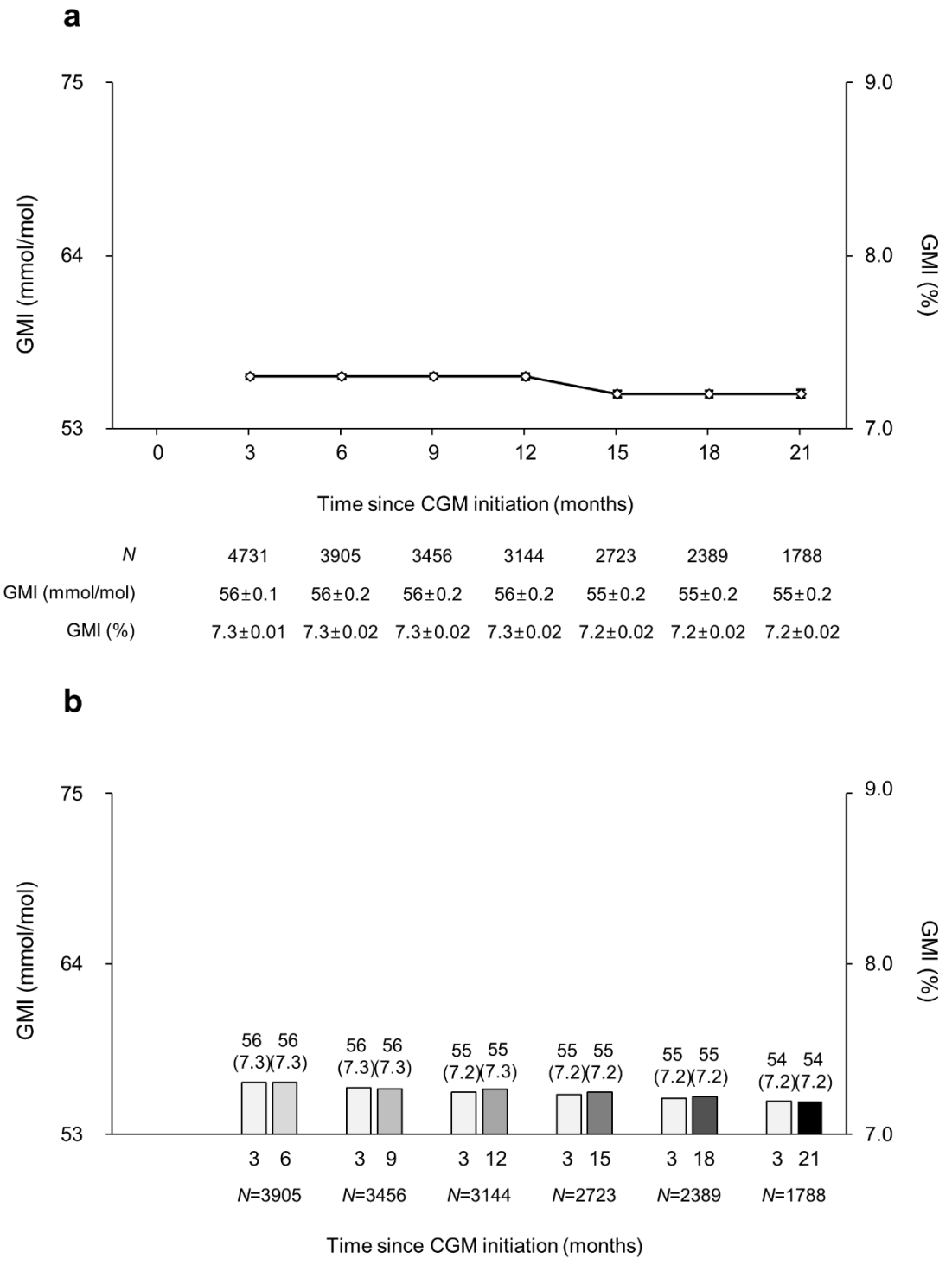
CGM, continuous glucose monitoring; CI, confidence interval; CV, coefficient of variation; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; ED, emergency department; ESKD, end-stage kidney disease; GMI, glucose management indicator; HR, hazard ratio; SH, severe hypoglycaemia.

ESM Fig. 1. Longitudinal changes in HbA_{1c} among CGM users. (a) Mean HbA_{1c} levels during 21 months of follow-up. (b) Comparisons of HbA_{1c} at baseline vs. 3 months and 3 months vs. each follow-up point.



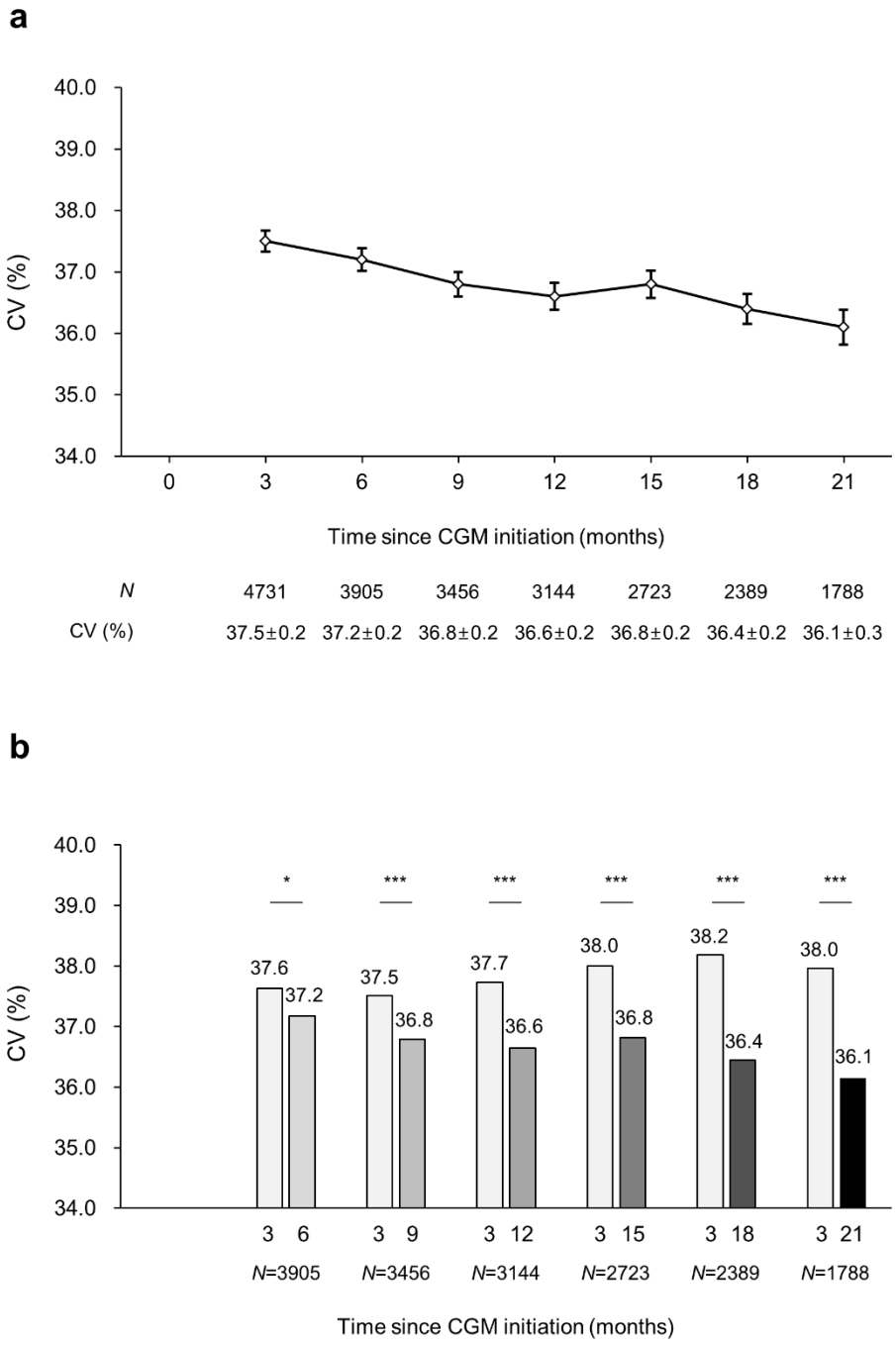
Values are presented as mean ± SEM in Panel (a).
Panel (a) shows mean HbA_{1c} levels among all CGM users with available data at each time point.
Panel (b) includes only individuals with available HbA_{1c} data at both time points and presents the mean HbA_{1c} values in mmol/mol (upper row) and percentage (lower row, in parentheses). *p<0.05, ***p<0.001.
CGM, continuous glucose monitoring.

ESM Fig. 2. Longitudinal changes in GMI among CGM users. (a) Mean GMI levels during 21 months of follow-up. (b) Comparisons of GMI at 3 months vs. each follow-up point.



Values are presented as mean ± SEM in Panel (a).
Panel (a) shows mean GMI levels among all CGM users with available data at each time point.
Panel (b) includes only individuals with available GMI data at both time points and presents the mean GMI values in mmol/mol (upper row) and percentage (lower row, in parentheses).
CGM, continuous glucose monitoring; GMI, glucose management indicator.

ESM Fig. 3. Longitudinal changes in glucose CV among CGM users. (a) Mean CV levels during 21 months of follow-up. (b) Comparisons of CV at 3 months vs. each follow-up point.



Values are presented as mean ± SEM in Panel (a).
Panel (a) shows mean CV levels among all CGM users with available data at each time point.
Panel (b) includes only individuals with available CV data at both time points and presents the mean CV values.
*p<0.05, ***p<0.001.
CGM, continuous glucose monitoring; CV, coefficient of variation.