

Supplementary Materials to: Association Between Treatment Adherence and Continuous Glucose Monitoring Outcomes in People With Diabetes Using Smart Insulin Pens in a Real-World Setting

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Supplementary Table 1—Study population characteristics in the type 1 diabetes subgroup

Characteristic	Type 1 diabetes cohort (<i>N</i> = 670)
14-day periods, <i>n</i> (n per individual)	6,380 (9.5)
CGM days, <i>n</i> (n per individual)	85,707 (127.9)
Days with degludec injections, <i>n</i> (n per individual)	77,768 (116.1)
Days with bolus insulin injections, <i>n</i> (n per individual)	81,435 (121.5)
Age, years	39.6 (14.9)
Mobile application, <i>n</i> (%)	
Abbott FreeStyle LibreLink	—*
Glooko/Diasend	325 (48.5)
Diasend	145 (21.6)
Glooko	200 (29.9)
Sex, <i>n</i> (%)[†]	
Female	282 (46.8)
Male	321 (53.2)
Country, <i>n</i> (%)	
Sweden	335 (50.0)
UK	103 (15.4)
Norway	64 (9.6)
Denmark	39 (5.8)
Czech Republic	35 (5.2)
Spain	21 (3.1)

Finland	20 (3.0)
Japan	19 (2.8)
Other‡	34 (5.1)
Diabetes type, <i>n</i> (%)	
Unknown	0
Type 1	670 (100.0)
Other	0
Bolus insulin, <i>n</i> (%)	
Faster aspart	397 (59.3)
Aspart	273 (40.7)
Basal insulin, <i>n</i> (%)	
Degludec	670 (100.0)
CGM interval, <i>n</i> (%)[§]	
900 s	276 (41.2)
300 s	392 (58.5)
600 s	2 (0.3)
CGM-derived metrics	
TIR, %	54.1 (19.9)
TAR >10.0 mmol/L, %	42.5 (21.4)
TAR >13.9 mmol/L, %	18.3 (17.4)
TBR <3.9 mmol/L, %	3.4 (3.4)
TBR <3.0 mmol/L, %	0.6 (0.9)
Mean glucose concentration, mmol/L	10.0 (2.4)

%CV	32.2 (5.3)
GMI score, %	7.6 (1.0)
Smart insulin pen data	
Upload days, <i>n</i> /14 days	2.1 (2.8)
Missed basal insulin doses, <i>n</i> /14 days	0.4 (0.6)
Missed bolus insulin doses, <i>n</i> /14 days	8.2 (5.4)
Bolus insulin doses, <i>n</i> /day	4.5 (1.6)
Bolus insulin doses, <i>n</i> /14 days	55.4 (23.5)
Basal insulin dose, U/day	27.5 (18.4)
Bolus insulin dose, U/day	30.1 (18.7)

Data shown are mean (SD) values unless otherwise indicated. *No data were recorded in the type 1 diabetes subgroup for the Abbott app. †If data were available; not all apps recorded the sex of the participants. Data were available for 603 participants (90.0%) with known type 1 diabetes. ‡Other countries were Austria, Belgium, France, Germany, the Netherlands, Poland, the Republic of Ireland, and Switzerland; if the country was missing, this was captured as 'other'. §The brand and model details for CGM devices were unknown; the interval between readings was inferred from the CGM data. %CV, coefficient of variation; aspart, insulin aspart; CGM, continuous glucose monitoring; degludec, insulin degludec; faster aspart, fast-acting insulin aspart; GMI, glucose management indicator; SD, standard deviation; TAR >10.0 mmol/L, time above range >10.0 mmol/L; TAR >13.9 mmol/L, time above range >13.9 mmol/L; TBR <3.9 mmol/L, time below range <3.9 mmol/L; TBR <3.0 mmol/L, time below range <3.0 mmol/L; TIR, time in range (3.9–10.0 mmol/L); U, units.

Supplementary Table 2—Frequency and probability of missed basal and missed bolus insulin doses in the basal-bolus group

Response	Frequency of occurrence over a 14-day period, <i>n</i>	Estimated probability of at least one occurrence over a 14-day period, %
Missed basal insulin dose	0.19 (0.18, 0.21)	17.6 (16.5, 18.7)
Missed bolus insulin dose	6.0 (5.9, 6.1)	99.1 (98.7, 99.4)

Data are shown as mean (95% CI).

Supplementary Table 3—Frequency and probability of missed basal and missed bolus insulin doses in the type 1 diabetes subgroup

Response	Frequency of occurrence over a 14-day period, <i>n</i>	Estimated probability of at least one occurrence over a 14-day period, %
Missed basal insulin dose	0.18 (0.16, 0.20)	16.5 (14.4, 18.9)
Missed bolus insulin dose	6.6 (6.2, 7.0)	98.4 (97.7, 98.9)

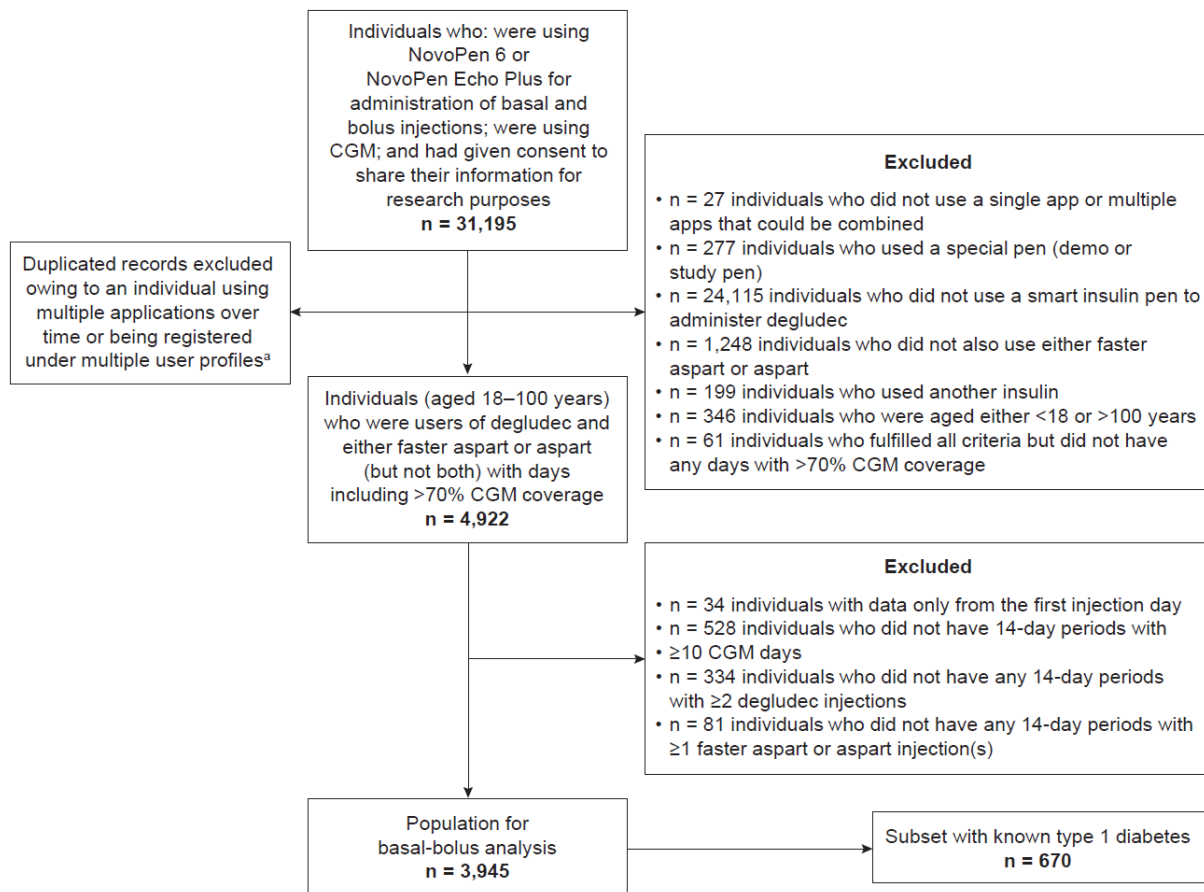
Data are shown as mean (95% CI).

Supplementary Table 4—Associations between insulin doses and numbers of days with data uploads over a 14-day period with glycemic outcomes in the type 1 diabetes subgroup

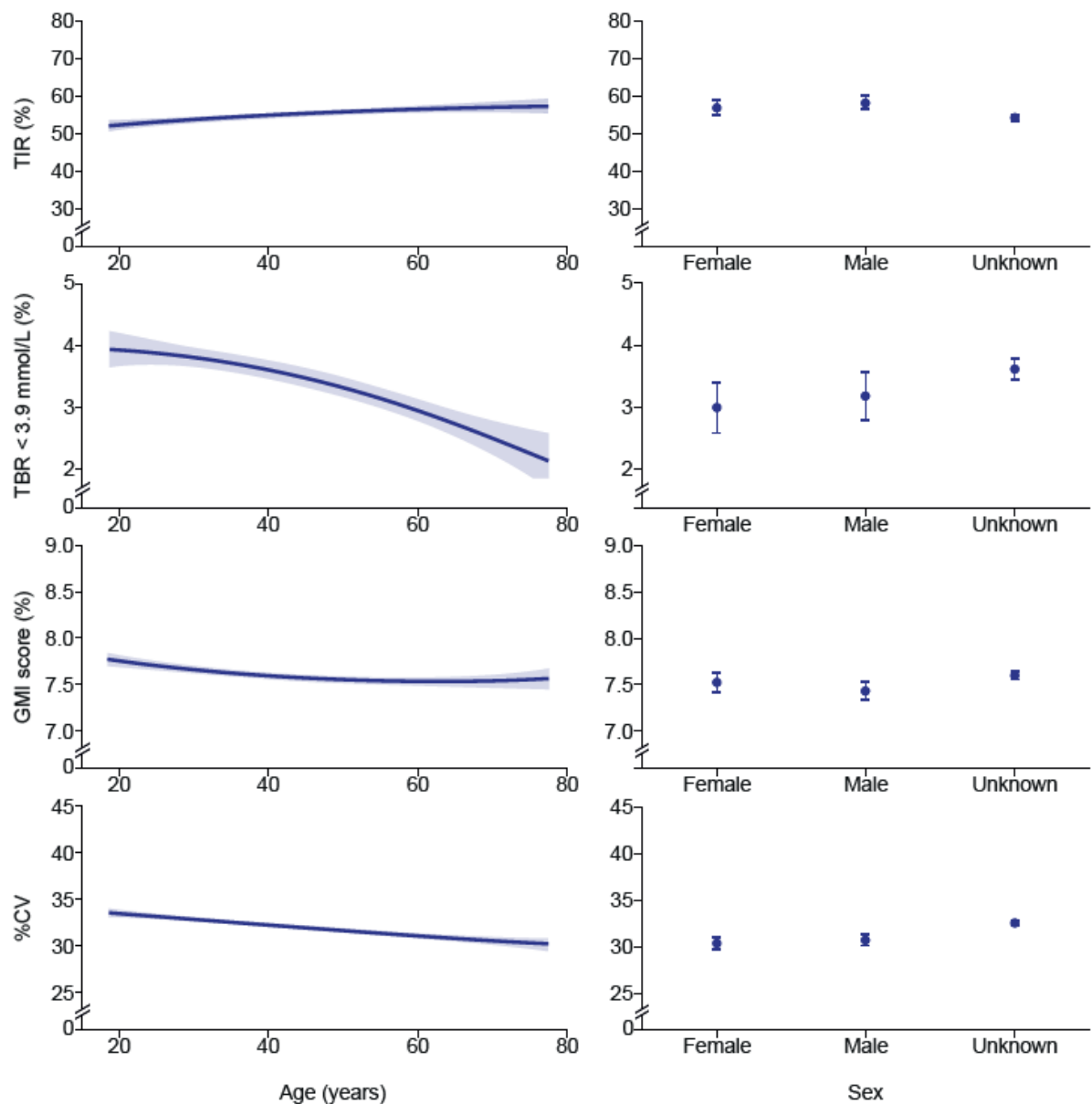
Response	Missed basal dose	Missed bolus dose	Daily bolus injection	Days with data uploads
TIR, %				
Slope (95% CI)	−4.35 (−6.52, −2.18)	−1.48 (−1.72, −1.24)	3.08 (2.29, 3.86)	0.78 (0.36, 1.21)
<i>P</i> value	0.0001	< 0.0001	< 0.0001	0.0004
TAR >10.0 mmol/L, %				
Slope (95% CI)	4.35 (1.99, 6.70)	1.63 (1.37, 1.90)	−3.16 (−4.01, −2.30)	−0.76 (−1.23, −0.30)
<i>P</i> value	0.0004	< 0.0001	< 0.0001	0.0013
TAR >13.9 mmol/L, %				
Slope (95% CI)	5.02 (3.14, 6.89)	1.25 (1.04, 1.45)	−2.71 (−3.39, −2.03)	−0.49 (−0.86, −0.13)
<i>P</i> value	< 0.0001	< 0.0001	< 0.0001	0.0091
TBR <3.9 mmol/L, %				
Slope (95% CI)	0.02 (−0.46, 0.49)	−0.16 (−0.21, −0.10)	0.07 (−0.10, 0.24)	−0.01 (−0.10, 0.08)
<i>P</i> value	0.9480	< 0.0001	0.4114	0.7971

TBR <3.0 mmol/L, %				
Slope (95% CI)	0.07 (−0.06, 0.20)	−0.01 (−0.03, 0.00)	0.03 (−0.02, 0.07)	−0.01 (−0.03, 0.02)
<i>P</i> value	0.2680	0.0733	0.2738	0.5198
Mean glucose concentration, mmol/L				
Slope (95% CI)	0.66 (0.40, 0.92)	0.18 (0.15, 0.21)	−0.36 (−0.46, −0.27)	−0.07 (−0.12, −0.02)
<i>P</i> value	< 0.0001	< 0.0001	< 0.0001	0.0079
GMI score, %				
Slope (95% CI)	0.28 (0.17, 0.40)	0.08 (0.06, 0.09)	−0.16 (−0.20, −0.12)	−0.03 (−0.05, −0.01)
<i>P</i> value	< 0.0001	< 0.0001	< 0.0001	0.0079
%CV				
Slope (95% CI)	0.19 (−0.51, 0.88)	0.22 (0.14, 0.29)	−0.04 (−0.29, 0.21)	−0.16 (−0.30, −0.02)
<i>P</i> value	0.5976	< 0.0001	0.7438	0.0217

Between-individual effects ($N = 670$). The presented data include estimated regression coefficients (slope) with 95% CI. Headers show individual-level parameters, calculated as averages over the 14-day blocks for each individual. The regression coefficient shows that, for example, if you compare two individuals with equal characteristics, except one has on average one more missed basal insulin dose per 14-days, then this individual would have a mean decrease in TIR of -4.35% . %CV, coefficient of variation; GMI, glucose management indicator; TAR >10.0 mmol/L, time above range >10.0 mmol/L; TAR >13.9 mmol/L, time above range >13.9 mmol/L; TBR <3.9 mmol/L, time below range <3.9 mmol/L; TBR <3.0 mmol/L, time below range <3.0 mmol/L; TIR, time in range (3.9–10.0 mmol/L).



Supplementary Figure 1—Selection of the data analysis population. *If multiple user IDs had data from the same smart insulin pen, identified by a unique serial number, it was assumed that these user IDs belonged to the same person and were considered equivalent. Data from equivalent user IDs were combined into one coherent data set. Aspart, insulin aspart; CGM, continuous glucose monitoring; faster aspart, fast-acting insulin aspart; ID, identifier.



Supplementary Figure 2—Associations between age and sex with glycemic outcomes in the basal-bolus population. Between-individual effects ($N = 3,945$). %CV, coefficient of variation; GMI, glucose management indicator; TBR <3.9 mmol/L, time below range <3.9 mmol/L; TIR, time in range (3.9–10.0 mmol/L).