

Supplemental Table S1: Characteristics of participants with incident type 1 diabetes who completed both study visits compared to those who dropped out

	Completers (n=36)	Non-completers (n=5)	p
Female, n (%)	14 (39)	2 (40)	0.96
Age at enrollment, y	14.2 (12-15.4) ¹	11 (10.7-11.2)	0.03
Racial group, n (%)			<0.001
White	31 (86.1)	1 (20)	
Black	3 (8.3)	1 (20)	
Hispanic/Latino	2 (5.6)	1 (20)	
Other/mixed race	0 (0)	2 (40)	
HbA1c at diagnosis, %	12.9 (11-14)	13.1 (10-14)	0.72
Fracture history, n (%)	16 (44.4)	3 (60)	0.51
Calcium intake, mg/d	1422 ± 550	1259 ± 472	0.53
25-OH Vitamin D, ng/mL	27.3 ± 8.9 ²	25.2 ± 5.9 ²	0.67
Hemoglobin A1c, %	12.9 (11-14)	13.1 (10.2-13.4)	0.73
A1c >7.5	36 (100)	5 (100)	0.99
≥ 1 T1D ab⁴ positive, n (%)	36 (100)	5 (100)	0.99
3 T1D ab positive, n(%)	14 (38.9)	3 (60)	0.37

¹ Median (interquartile range), all such values

² n=26, performed in The Children's Hospital of Philadelphia clinical lab

³ n=4, performed in The Children's Hospital of Philadelphia clinical lab

⁴ Glutamic acid decarboxylase antibody, insulin auto-antibody, or insulinoma antigen 2 antibody

Supplemental Table S2: Anthropometry and body composition from DXA and pQCT in 36 participants with incident T1D, overall and stratified by glycemic control

Entire Cohort	Baseline	p¹	12-Month	p¹	12 Month Change	p (change from baseline)²
Height Z-score	0.29 ± 1.10	0.28	0.34 ± 1.11	0.15	0.05 ± 0.29	0.34
Weight Z-score	0.25 ± 1.00	0.15	0.52 ± 0.98	N/A	0.28 ± 0.49	0.002
BMI Z-score	0.12 ± 1.05	0.11 ³	0.42 ± 0.95	0.52 ³	0.31 ± 0.56	0.003
FMI Z-score	-0.14 ± 0.67	0.22 ⁴	0.21 ± 0.59 ⁵	N/A	0.26 ± 0.37 ⁵	0.001
LBMI Z-score	-0.64 ± 1.00	0.001 ⁴	-0.52 ± 0.89 ⁵	N/A	0.09 ± 0.51 ⁵	0.37
Tibia fat area Z-score	-0.24 ± 0.89	0.11	0.09 ± 0.90 ⁶	0.58	0.33 ± 0.52 ⁶	0.001
Tibia muscle area Z-score	-0.23 ± 1.03	0.19	0.04 ± 0.98 ⁶	0.82	0.29 ± 0.46 ⁶	0.001
Good Glycemic Control (n=21)	Baseline	p⁷	12-Month	p⁷	12 Month Change	p² / p⁷
Height Z-score	0.35 ± 1.02	0.71	0.42 ± 1.06	0.63	0.06 ± 0.34	0.37 / 0.65
Weight Z-score	0.13 ± 1.13	0.49	0.57 ± 1.14	0.76	0.43 ± 0.38	<0.001 / 0.03
BMI Z-score	-0.06 ± 1.20	0.24	0.43 ± 1.15	0.99	0.48 ± 0.45	0.001 / 0.02
FMI Z-score	-0.29 ± 0.72	0.15	0.22 ± 0.74 ⁵	0.86	0.40 ± 0.30 ⁵	0.001 / 0.06
LBMI Z-score	-0.83 ± 1.15	0.22	-0.61 ± 1.12 ⁵	0.59	0.22 ± 0.44 ⁵	0.09 / 0.18
Tibia fat area Z-score	-0.32 ± 0.96	0.55	0.18 ± 1.01	0.45	0.50 ± 0.48	0.001 / 0.02

Tibia muscle area Z-score	-0.35 ± 1.00	0.43	0.02 ± 1.11	0.90	0.37 ± 0.41	0.001 / 0.22
Poor Glycemic Control (n=15)	Baseline	p⁷	12-Month	p⁷	12 Month Change	p² / p⁷
Height Z-score	0.21 ± 1.24	0.71	0.23 ± 1.23	0.63	0.02 ± 0.24	0.74 / 0.65
Weight Z-score	0.39 ± 0.97	0.49	0.46 ± 0.75	0.76	0.07 ± 0.08	0.61 / 0.03
BMI Z-score	0.37 ± 0.77	0.24	0.42 ± 0.61	0.99	0.05 ± 0.62	0.74 / 0.02
FMI Z-score	0.04 ± 0.57	0.15	0.19 ± 0.42	0.86	0.14 ± 0.41	0.20 / 0.06
LBMI Z-score	-0.40 ± 0.61	0.22	-0.43 ± 0.61	0.59	-0.04 ± 0.55	0.81 / 0.18
Tibia fat area Z-score	-0.14 ± 0.79	0.55	-0.06 ± 0.72 ⁸	0.45	0.08 ± 0.50 ⁸	0.56 / 0.02
Tibia muscle area Z-score	-0.07 ± 1.08	0.43	0.06 ± 0.77 ⁸	0.90	0.17 ± 0.53 ⁸	0.24 / 0.22

FMI, fat mass index; LBMI, lean body mass index; fat area, and muscle area adjusted for tibia length Z-score.

¹ vs BMDCS reference population, using 1 sample t-test

² 12 month vs baseline in T1D, paired ttest

³ compared to data for BMDCS reported by McCormack, et al (1), using 2 sample t-test

⁴ compared to NHANES reference data (2)

⁵ excludes 6 participants with visible pump or CGM on 12-month scan

⁶ n=35

⁷ participants with good vs poor glycemic control

⁸ n=14

References

1. McCormack SE, Cousminer DL, Chesi A, Mitchell JA, Roy SM, Kalkwarf HJ, Lappe JM, Gilsanz V, Oberfield SE, Shepherd JA, Winer KK, Kelly A, Grant SFA, Zemel BS. Association Between Linear Growth and Bone Accrual in a Diverse Cohort of Children and Adolescents. *JAMA Pediatr* 2017; 171:e171769
2. Weber DR, Moore RH, Leonard MB, Zemel BS. Fat and lean BMI reference curves in children and adolescents and their utility in identifying excess adiposity compared with BMI and percentage body fat. *Am J Clin Nutr* 2013; 98:49-56

Supplementary Table S3: Bone accrual in the year following diagnosis of type 1 diabetes in 36 participants, overall and stratified by glycemic control

	Entire Cohort	p ¹	Good Glycemic Control at 12 Months (n=21)	Poor Glycemic Control at 12 Months (n=15)	p ²
TBLH BMC velocity³	0.11 ± 0.90	0.52	0.58 ± 0.71	-0.36 ± 0.84	0.003
LS aBMD velocity	-0.18 ± 1.02	0.31	-0.04 ± 0.94	-0.37 ± 1.12	0.33
Total hip aBMD velocity	-0.05 ± 1.08	0.77	0.41 ± 0.87	-0.72 ± 1.03	0.002
Femoral neck aBMD velocity	0.31 ± 1.16	0.12	0.81 ± 1.04	-0.39 ± 0.94	0.002
Distal 1/3 radius aBMD velocity	-0.17 ± 1.11	0.36	-0.5 ± 1.09	-0.34 ± 1.16	0.45

TBLH, total body less head; BMC, bone mineral content; LS lumbar spine; aBMD, areal bone mineral density. BMC and aBMD velocity Z-scores respective to age, sex, tanner stage adjusted for baseline BMC or aBMD, age, height, height velocity. Reported p-values are from t-tests. When stratified by glycemic control, distributions for TBLH BMC and distal 1/3 radius aBMD velocity were non-parametric, however significance did not change when compared by Wilcoxon rank sum (p=0.001 and 0.84, respectively).

¹ vs BMDCS reference population

² good (HbA1c < 7.5%) vs poor (HbA1c ≥ 7.5%) glycemic control

³ excludes 6 participants with visible pump or CGM on 12-month scan

Supplemental Table S4: Sensitivity analyses of relationships between glycemic control and bone accrual outcomes in 36 T1D participants

Bone accrual outcome Z-score	β (95% CI), p	
Sensitivity analyses adjusting for effect of DXA machine		
	Model 1 (Univariate)	Model 2 (Adjusted for Old DXA machine)
TBLH BMC Velocity¹	<i>Poor Glycemic Control: -0.93 (-1.51, -0.35), 0.003</i>	<i>Poor Glycemic Control: -1.05 (-1.70, -0.39), 0.003</i> <i>Old Machine: -0.28 (-1.02, 0.47), 0.45</i>
LS BMD Velocity	Poor Glycemic Control: -0.34 (-1.04, 0.36), 0.33	Poor Glycemic Control: -0.51 (-1.25, 0.24), 0.18 Machine: -0.51 (-1.32, 0.31), 0.22
Total Hip BMD Velocity²	<i>Poor Glycemic Control: -1.13 (-1.79, -0.46), 0.002</i>	<i>Poor Glycemic Control: -0.94 (-1.61, -0.26), 0.008</i> <i>Machine: 0.67 (-0.08, 1.43), 0.08</i>
Femoral Neck BMD Velocity²	<i>Poor Glycemic Control: -1.21 (-1.92, -0.51), 0.002</i>	<i>Poor Glycemic Control: -1.22 (-1.98, -0.47), 0.03</i> <i>Machine: -0.04 (-0.89, 0.81), 0.92</i>
Distal 1/3 Radius BMD Velocity³	Poor Glycemic Control: -0.29 (-1.07, 0.49), 0.46	Poor Glycemic Control: -0.03 (-0.88, 0.80), 0.94 Machine: 0.69 (-0.26, 1.64), 0.15
Sensitivity analyses adjusting for 25-OH vitamin D		
	Model 1 (Univariate)	Model 2 (Adjusted for Vitamin D)
TBLH BMC Velocity¹	<i>Poor Glycemic Control: -0.93 (-1.51, -0.35), 0.003</i>	<i>Poor Glycemic Control: -0.83 (-1.56, -0.11), 0.02</i> <i>25-OH Vitamin D: 0.01 (-0.04, 0.06), 0.62</i>
LS BMD Velocity	Poor Glycemic Control: -0.34 (-1.04, 0.36), 0.33	Poor Glycemic Control: -0.34 (-1.17, 0.49), 0.41 25-OH Vitamin D: 0.01 (-0.05, 0.05), 0.99
Total Hip BMD Velocity²	<i>Poor Glycemic Control: -1.13 (-1.79, -0.46), 0.002</i>	<i>Poor Glycemic Control: -1.04 (-1.83, -0.24), 0.01</i> <i>25-OH Vitamin D: 0.01 (-0.04, 0.06), 0.67</i>

Femoral Neck BMD Velocity²	Poor Glycemic Control: <i>-1.21 (-1.92,-0.51), 0.002</i>	<i>Poor Glycemic Control: -1.10 (-1.92,-0.28), 0.01</i> 25-OH Vitamin D: 0.01 (-0.04,0.07), 0.56
Distal 1/3 Radius BMD Velocity³	Poor Glycemic Control: <i>-0.29 (-1.07,0.49), 0.46</i>	Poor Glycemic Control: <i>-0.10 (-1.01,0.82), 0.83</i> 25-OH Vitamin D: 0.02 (-0.03,0.08), 0.42
Δ Tibia Cortical Area	<i>Poor Glycemic Control: -0.26 (-0.44, -0.09), 0.005</i>	<i>Poor Glycemic Control: -0.21 (-0.42, -0.01), 0.04</i> 25-OH Vitamin D: 0.01 (-0.01, 0.02), 0.38
Δ Tibia Periosteal Circumference	<i>Poor Glycemic Control: -0.18 (-0.3, -0.06), 0.006</i>	<i>Poor Glycemic Control: -0.14 (-0.29,-0.01), 0.04</i> 25-OH Vitamin D: 0.01 (-0.01, 0.01), 0.41

Sensitivity analyses defining poor glycemic control based upon average HbA1c

	Model 1 (Based upon HbA1c at 12-month visit)	Model 2 (Based upon average HbA1c)
TBLH BMC Velocity¹	<i>Poor Control @ 12-Mo: -0.93 (-1.51, -0.35), 0.003</i>	<i>Poor Control Avg: -0.89 (-1.53, -0.26), 0.008</i>
LS BMD Velocity	<i>Poor Control @ 12-Mo: -0.34 (-1.04, 0.36), 0.33</i>	<i>Poor Control Avg: -0.75 (-1.48,-0.01), 0.05</i>
Total Hip BMD Velocity²	<i>Poor Control @ 12-Mo: -1.13 (-1.79,-0.46), 0.002</i>	<i>Poor Control Avg: -1.25 (-1.97, -0.54), 0.001</i>
Femoral Neck BMD Velocity²	<i>Poor Control @ 12-Mo: -1.21 (-1.92,-0.51), 0.002</i>	<i>Poor Control Avg: -1.12 (-1.92,-0.31), 0.008</i>
Distal 1/3 Radius BMD Velocity³	<i>Poor Control @ 12-Mo: -0.29 (-1.07,0.49), 0.46</i>	<i>Poor Control Avg: -0.49 (-1.32, 0.36), 0.25</i>

Sensitivity analyses defining bone accrual by change in 12-month BMC or aBMD Z-score

	Model 1 (Univariate)	Model 2 (Adjusted for Relevant Covariates)
Δ TBLH BMC^{1,2}	<i>Poor Glycemic Control: -0.25 (-0.43,-0.06), 0.01</i>	<i>Poor Glycemic Control: -0.21 (-0.41,-0.1), 0.04</i> Baseline TBLH BMC Z: <i>-0.02 (-0.16,0.13), 0.82</i> Age (y): <i>-0.05 (-0.12,0.03), 0.19</i> Height (cm): <i>0.01 (-0.01,0.02), 0.16</i>
Δ LS aBMD	<i>Poor Glycemic Control: -0.06 (-0.26, 0.15), 0.59</i>	<i>Poor Glycemic Control: 0.02 (-0.24, 0.19), 0.84</i> Baseline LS aBMD Z: <i>-0.09 (-0.22,0.03), 0.13</i> Age (y): <i>0.02 (-0.11,0.07), 0.64</i> Height (cm): <i>0.01 (-0.01,0.01), 0.93</i>

Height Velocity (cm/yr): 0.02 (-0.02,0.05), 0.41

Δ Total Hip aBMD²

Poor Glycemic Control: -0.30 (-0.49, -0.11), 0.003

Poor Glycemic Control: -0.25 (-0.43, -0.06), 0.01
Baseline Hip aBMD Z: -0.12 (-0.23, -0.02), 0.02
Age (y): -0.02 (-0.10, 0.05), 0.51
Height (cm): 0.01 (-0.01, 0.02), 0.56
Height Velocity (cm/yr): -0.02 (-0.05, 0.14), 0.25

Δ Fem Neck aBMD²

Poor Glycemic Control: -0.39 (-0.61, -0.16), 0.002

Poor Glycemic Control: -0.32 (-0.54, -0.10), 0.01
Baseline Neck aBMD Z: -0.17 (-0.29, -0.06), 0.01
Age (y): 0.01 (-0.11, 0.09), 0.82
Height (cm): -0.01 (-0.05,0.04), 0.89
Height Velocity (cm/yr): -0.01 (-0.05,0.04), 0.89

Δ Distal 1/3 Radius aBMD³

Poor Glycemic Control: -0.18 (-0.51, 0.16), 0.29

Poor Glycemic Control: -0.04 (-0.39,0.30), 0.81
Baseline Rad aBMD Z: -0.1 (-0.24,0.04), 0.15
Age (y): -0.11 (-0.23,0.02), 0.10
Height (cm): 0.01 (-0.01,0.03), 0.18
Height Velocity (cm/yr): -0.01 (-0.07,0.06), 0.88

TBLH, total body less head; BMC, bone mineral content, aBMD, areal bone mineral density; LS, lumbar spine; Fem Neck, femoral neck; Rad, radius. BMC/BMD velocity Z-scores respective to age, sex, tanner stage adjusted for baseline BMC, age, height, height velocity. pQCT Z-scores adjusted for tibia-length Z-score. Good glycemic control defined as HbA1c <7.5%; poor glycemic control as HbA1c ≥ 7.5%. 25-OH vitamin expressed as ng/mL.

¹ n=30, excludes 6 participants with visible pump on 12 month DXA scan

² n=34

³ n=35

Sensitivity analyses of BMC or aBMD velocity Z-scores additionally adjusting for change in weight or lean body mass in the year following T1D diagnosis in 36 participants

	Entire Cohort	p ¹	Good Glycemic Control at 12 Months (n=21)	Poor Glycemic Control at 12 Months (n=15)	p ²
<u>Further adjusted for baseline weight and weight velocity</u>					
TBLH BMC³ velocity	-0.06 ± 0.87	0.72	0.30 ± 0.73	-0.42 ± 0.87	0.02
LS aBMD velocity	-0.29 ± 0.99	0.09	-0.21 ± 0.93	-0.41 ± 1.08	0.54
Total hip aBMD velocity	-0.26 ± 0.96	0.12	0.11 ± 0.81	-0.79 ± 0.93	0.005
Femoral neck aBMD velocity	0.11 ± 1.03	0.53	0.52 ± 1.00	-0.47 ± 0.78	0.004
Distal 1/3 radius aBMD velocity	-0.20 ± 1.09	0.29	-0.09 ± 1.07	-0.34 ± 1.14	0.51
<u>Further adjusted for baseline lean body mass and lean body mass velocity</u>					
TBLH BMC³ velocity	0.13 ± 0.90	0.45	0.46 ± 0.71	-0.21 ± 0.97	0.04
LS aBMD velocity	0.07 ± 1.05	0.67	0.17 ± 1.00	-0.06 ± 1.13	0.51
Total hip aBMD velocity	-0.11 ± 1.00	0.54	0.27 ± 0.87	-0.65 ± 0.96	0.007
Femoral neck aBMD velocity	0.42 ± 1.17	0.04	0.95 ± 1.12	-0.33 ± 0.78	0.001
Distal 1/3 radius aBMD velocity	-0.13 ± 1.09	0.49	-0.02 ± 1.06	-0.27 ± 1.14	0.51

TBLH, total body less head; BMC, bone mineral content; LS lumbar spine; aBMD, areal bone mineral density. BMC and aBMD velocity Z-scores respective to age, sex, tanner stage and adjusted for baseline BMC or aBMD, age, height, height velocity and either baseline weight +

weight velocity or baseline lean body mass + lean body mass velocity. Reported p-values are from t-tests. When stratified by glycemic control, distributions for weight adjusted TBLH BMC, LS aBMD distal 1/3 radius aBMD, and lean body mass adjusted LS aBMD and distal 1/3 radius aBMD velocity were non-parametric, however significance did not change when compared by Wilcoxon rank sum (p=0.02, 0.55, 0.97, 0.36, and 0.95, respectively).

¹ vs BMDCS reference population

² Good (HbA1c < 7.5%) vs poor (HbA1c ≥ 7.5%) glycemic control

³ excludes 6 participants with visible pump or CGM on 12-month scan

Supplemental Table S5: Biochemical markers of bone mineral metabolism in 36 participants with incident type 1 diabetes

	Entire Cohort at baseline (n=36)	Entire Cohort at 12 Month (n=36)	p ¹	Good Glycemic Control at 12 months (n=21)	Poor Glycemic Control at 12 months (n=15)	p ²
25-OH Vitamin D, ng/mL	27.9 ± 7.1 ³	28.9 ± 8.2	0.33	32.1 ± 8.0	24.1 ± 5.5	0.001
25-OH Vitamin D, nmol/L	69.6 ± 17.8	72.1 ± 20.5	0.33	80.1 ± 19.9	60.2 ± 13.7	0.001
1,25-OH Vitamin D, pg/mL	34.8 (26.4-46.0) ⁴	47.1 (39.6-54.6)	0.001	49.3 (41.1-59.4)	46.5 (32.9-50.2)	0.16
1,25-OH Vitamin D, pmol/L	83.5 (63.4-110.4)	113.0 (95.0-131.0)	0.001	118.3 (98.6-142.6)	111.6 (78.9-120.5)	0.16
24,25-OH Vitamin D3, ng/mL	1.7 (1.2-2.4)	1.7 (1.2-2.4)	0.28	1.9 (1.3-2.8)	1.5 (1.1-1.8)	0.04
24,25-OH Vitamin D3, nmol/L	4.0 (2.9-5.9)	4.1 (3.0-5.7)	0.28	4.6 (3.1-6.8)	3.7 (2.6-4.3)	0.04
BSAP, ug/L	37.5 (24.6-70.7)	48.9 (24.9-88.5)	0.08	45.9 (29.2-76.7)	54.7 (17.8-106.1)	0.98
β-CTX, pg/mL	1200 (800-1700)	900 (800-1300)	0.07	900 (800-1200)	900 (700-1300)	0.72
β-CTX, ng/L	1200 (800-1700)	900 (800-1300)	0.07	900 (800-1200)	900 (700-1300)	0.72
Intact PTH, pg/mL	18.5 (14.8-26.7)	26.9 (18.9-32.4)	0.003	27.4 (23.6-29.6)	25.5 (16.2-43.8)	0.77
Intact PTH, ng/L	18.5 (14.8-26.7)	26.9 (18.9-32.4)	0.003	27.4 (23.6-29.6)	25.5 (16.2-43.8)	0.77
Calcium, mg/dL	9.6 ± 0.4	9.8 ± 0.3	0.005	9.8 ± 0.4	9.9 ± 0.3	0.13
Calcium, mmol/L	2.4 ± 0.1	2.5 ± 0.1	0.005	2.5 ± 0.1	2.5 ± 0.1	0.13
Magnesium, mg/dL	1.9 ± 0.1	1.9 ± 0.1	0.001	1.9 ± 0.1	1.9 ± 0.1	0.55
Magnesium, mmol/L	0.77 ± 0.04	0.81 ± 0.05	0.001	0.80 ± 0.05	0.79 ± 0.06	0.55

Phosphorus, mg/dL	4.5 ± 0.7	4.0 ± 0.6	0.002	4.1 ± 0.5	3.9 ± 0.6	0.46
Phosphorus, mmol/L	1.5 ± 0.2	1.3 ± 0.2	0.002	1.3 ± 0.2	1.3 ± 0.2	0.46
Urine Ca/Cr	0.12 (0.07-0.15)	0.10 (0.05-0.14)	0.05	0.09 (0.05-0.13)	0.13 (0.03-0.15)	0.48

β-CTX, C-telopeptide, beta-cross linked; BSAP, bone specific alkaline phosphatase. Data provided for 25-OHD and 1,25-OHD are for total of vitamin D2+vitamin D3; data for 24,25-OHD is for vitamin D3 alone. Good glycemic control defined as HbA1c < 7.5%; poor glycemic control as HbA1c ≥ 7.5%.

¹ Comparison of baseline vs 12 months

² Comparison of 12 month in participants with good vs poor glycemic control

³ Mean ± standard deviation, all such values

⁴ Median (interquartile range), all such values