Table 1. Mean (± 1SD) DXA variables for controls and football players at each measurement point

	Time 1		Time 2		Time 3		Time 4	
	Controls	Football players	Controls	Football players	Controls	Football players	Controls	Football players
Total Fat Mass (kg)	16.41±8.83	11.46±2.72	16.35±8.21	10.43±2.40	16.21±8.29	10.86±2.80	13.73±6.15	10.92±2.11
Total Lean Mass (kg)	58.12±7.28	66.06±5.91	58.14±7.38	67.77±6.50	58.61±7.75	67.23±6.23	60.03±7.16	67.43±6.35
Legs BMD (g/cm^2)	1.461±0.156	1.644±0.124	1.467±0.160	1.643±0.120	1.470±0.161	1.644±0.119	1.485±0.180	1.654±0.124
Total BMD (g/cm^2)	1.309±0.121	1.417±0.096	1.309±0.121	1.413±0.094	1.313±0.125	1.430±0.097	1.311±0.135	1.422±0.098
Legs BMC (g)	1286±204	1559±194	1286±205	1563±199	1287±203	1572±199	1314±229	1566±189
Total BMC (g)	3315±475	3802±442	3317±465	3807±456	3317±472	3860±478	3344±525	3834±466
Legs Area (cm^2)	877±70	947±81	873±67	949±80	872±67	954±75	881±72	945±72
Total Area (cm^2)	2523±167	2677±191	2525±164	2687±197	2518±168	2692±198	2540±189	2690±200

Note. BMD = DXA = Dual-energy x-ray absorptiometry, Bone mineral density, BMC = Bone mineral content.

Table 2. Mean (± 1SD) pQCT variables for controls and football players at each measurement point

	Time 1		Time 2		Time 3		Time 4	
	Controls	Football players	Controls	Football players	Controls	Football players	Controls	Football players
Mass 4% (g)	4.56±0.67	5.31±0.55	4.56±0.65	5.34±0.58	4.58±0.67	5.34±0.54	4.63±0.74	5.31±0.56
Mass 14% (g)	3.24±0.45	3.71±0.36	3.27±0.45	3.72±0.36	3.27±0.44	3.74±0.35	3.39±0.47	3.68±0.35
Mass 38% (g)	4.44±0.64	5.11±0.45	4.46±0.63	5.11±0.44	4.47±0.63	5.14±0.44	4.57±0.68	5.17±0.62
SSIPOL 14% (mm^3)	2008±390	2352±352	1996±403	2331±344	2031±391	2378±365	2128±339	2343±322
SSIPOL 38%(mm^3)	2121±438	2477±292	2140±430	2434±252	2153±437	2478±277	2264±473	2524±347
SSIX 14% (mm^3)	1114±216	1315±204	1118±211	1325±193	1118±210	1329±196	1175±204	1315±182
SSIX 38% (mm^3)	1392±310	1566±196	1390±287	1557±175	1414±295	1551±206	1487±348	1611±252
SSIY 14% (mm^3)	1181±227	1420±200	1188±226	1434±206	1189±214	1430±211	1254±211	1404±215
SSIY 38% (mm^3)	1159±245	1413±175	1173±251	1416±186	1175±248	1445±182	1202±249	1439±309
Area 4% (mm^2)	1263±175	1388±173	1259±172	1404±177	1266±173	1388±182	1268±188	1378±159
Area 14% (mm^2)	539±86	591±76	542±83	593±77	540±82	595±77	561±71	588±74
Area 38% (mm^2)	486±66	534±36	489±66	535±38	490±67	538±37	503±68	548±83
Density 4% ($mg \cdot cm^3$)	363.4±41.5	384.8±38.3	364.5±42.1	382.3±35.3	363.6±41.5	387.6±38.6	366.8±44.6	387.4±37.5
Density 14% ($mg \cdot cm^3$)	609.7±80.5	633.4±64.6	609.4±77.7	632.0±63.8	611.6±78.6	634.6±64.5	608.1±77.1	630.7±64.9

Density 38% ($mg \cdot cm^3$)	915.4±64.4	956.6±44.3	912.1±66.5	955.4±41.9	912.9±65.2	956.0±47.9	909.0±59.9	946.9±52.6
Cortical thickness 14% (mm)	3.00±0.51	3.40±0.45	3.01±0.49	3.38±0.44	3.02±0.49	3.40±0.44	3.05±0.54	3.40±0.46
Cortical thickness 38% (mm)	6.10±0.77	6.97±0.56	6.09±0.78	6.96±0.51	6.09±0.77	6.95±0.61	6.12±0.79	6.89±0.52
Periosteal circumference 14% (mm)	82.03±6.61	86.02±5.50	82.28±6.41	86.19±5.60	82.14±6.36	86.28±5.58	83.82±5.22	85.84±5.34
Periosteal circumference 38% (mm)	77.96±5.29	81.90±2.76	78.25±5.30	81.92±2.89	78.30±5.37	82.18±2.81	79.33±5.27	82.83±5.82
Endosteal circumference 14% (mm)	63.17±8.09	64.66±7.39	63.37±7.82	64.94±7.50	63.16±7.84	64.93±7.48	64.67±6.68	64.50±7.25
Endosteal circumference 38% (mm)	39.64±5.25	38.10±3.29	40.01±5.60	38.18±3.20	40.04±5.50	38.49±4.05	40.90±4.88	39.56±6.46

Note. SSIPOL = Polar stress strain index, SSIX = X stress strain index, SSIY = Y stress strain index.

Table 3. Multilevel models showing predicted changes across time in DXA variables for controls and football players.

	Fixed Part (Estimate ± SE)				Random Part (SD)				
	Controls at baseline (intercept)	Footballers at baseline (intercept)	Controls change across time	Footballers change across time	Random intercept for controls at baseline	Random intercept for footballers at baseline	Random slope for footballers' change across time	Residual variance	Final -2LL
Total Fat Mass (kg)	16.47±1.61	11.13±0.56*[b]	-0.17±0.10#	-0.17±0.10#	8.17	2.38	-	0.92	655
Total Lean Mass (kg)	58.01± 1.44	66.59±1.35* [c]	0.30±0.11#	0.35±0.10#	7.31	5.97	-	0.97	697
Legs BMD (g/cm^2)	1.463±0.030	1.642 ±0.026* [c]	0.002±0.003	0.004±0.003	0.152	0.114	-	0.032	-524
Total BMD (g/cm^2)	1.309±0.024	1.415±0.021*[b]	0.001± 0.002	0.004± 0.002#	0.118	0.089	-	0.014	-688
Legs BMC (g)	1286± 39	1560± 43* [c]	<-1±1	4±2#	200	190	7	10	1591
Total BMC (g)	3315± 91	3801± 97*[b]	1±4	18±6#	461	432	22	27	1907
Legs Area (cm^2)	876±13	949±17*[b]	-1±2	<-1±2	65	74	-	17	1607
Total Area (cm^2)	2523±32	2680±43*[b]	-1±3	4±3	161	190	-	29	1810

Note. For the fixed part of the models, separate intercepts for controls and footballers at baseline are displayed. Separate estimates of changes across time for controls and footballers are displayed. Changes across time relates to per occasion change. * indicates baseline differences between controls and footballers at $p<0.05$. Effect sizes (*d*) for comparison between controls and footballers at baseline are displayed as a=small (0.20-0.49), b= medium (0.50-0.79), and c = large (>0.79). #indicates changes across time for a given group, at $p<0.05$. For the random part of the models, random intercept for controls at baseline is the estimated inter-individual variation in intercepts for controls, presented as standard deviations. Random intercept for footballers at baseline is the estimated inter-individual variation in intercepts for footballers, presented as standard deviations. Random slope for footballers' change across time is the estimated inter-individual variation in the rate of change across time for footballers, present as standard

deviations. The residual variance is the estimated within-individual variation presented as standard deviations. Final -2LL is the -2 loglikelihood for the final model. DXA = Dual-energy x-ray absorptiometry, BMD = Bone mineral density, BMC = Bone mineral content.

Table 4. Multilevel models showing predicted changes across time in pQCT variables for controls and football players.

	Fixed Part (Estimate ± SE)				Random Part (SD)			
	Controls at baseline (intercept)	Footballers at baseline (intercept)	Controls change across time	Footballers change across time	Random intercept for controls at baseline	Random intercept for footballers at baseline	Residual variance	Final -2LL
Mass 4% (g)	4.57±0.13	5.32±0.12*[c]	<-0.01 ± 0.01	0.01 ± 0.01	0.65	0.53	0.06	-165
Mass 14% (g)	3.26±0.09	3.72±0.08*[c]	<0.01 ±<0.01	<0.01 ±<0.01	0.44	0.35	0.03	-403
Mass 38% (g)	4.45±0.12	5.10±0.10*[c]	0.01±0.01	0.03±0.01#	0.62	0.45	0.11	-52
SSIPOL 14% (mm^3)	2008±75	2345±77*[b]	8±8	6±7	380	340	69	2077
SSIPOL 38%(mm^3)	2129±87	2432±65*[b]	8±10	19±10	424	265	93	2144
SSIX 14% (mm^3)	1120±41	1318±43*[b]	-1±3	4±3	208	192	25	1780
SSIX 38% (mm^3)	1392±57	1553±44*[a]	10±7	11±7	287	190	64	2023
SSIY 14% (mm^3)	1189±43	1427±45*[c]	-1±4	-1±4	216	201	34	1857
SSIY 38% (mm^3)	1173±49	1409±43*[b]	<-1±9	15±9	239	181	83	2072
Area 4% (mm^2)	1258±33	1395±38*[b]	2±3	-2±3	169	169	30	1809
Area 14% (mm^2)	540±16	593±17*[a]	<1±1	<-1±1	82	74	9	1451
Area 38% (mm^2)	489±13	532±10*[b]	<1±2	4±2#	64	40	22	1626
Density 4% ($mg \cdot cm^3$)	365.3±8.1	383.8±8.0[a]	-0.6±0.6	1.0±0.6	40.9	35.6	5.6	1273
Density 14% ($mg \cdot cm^3$)	610.5 ±15.1	632.4±13.9 [a]	0.2±0.7	1.1±0.6	76.7	62.0	5.9	1340

Density 38% ($mg \cdot cm^3$)	912.0± 12.7	956.7±9.7*[b]	0.7±1.5	-1.0±1.5	63.5	41.7	13.9	1518
Cortical thickness 14% (mm)	3.01±0.09	3.39±0.10*[b]	<-0.01±0.01	0.01±0.01	0.48	0.42	0.06	-217
Cortical thickness 38% (mm)	6.08±0.15	6.97±0.12*[c]	<0.01±0.01	<-0.01±0.01	0.75	0.51	0.14	-7
Periosteal circumference 14% (mm)	82.16±1.24	86.14±1.20*[a]	0.02±0.07	-0.04±0.07	6.29	5.35	0.66	590
Periosteal circumference 38% (mm)	78.20±1.04	81.76±0.73*[b]	0.03±0.16	0.30±0.15	5.15	3.02	1.48	750
Endosteal circumference 14% (mm)	63.23±1.51	64.85±1.60	0.02±0.11	-0.08±0.10	7.67	7.13	0.98	706
Endosteal circumference 38% (mm)	39.98±1.09	37.96±0.82 [a]	0.01±0.23	0.35±0.22	5.24	3.18	2.12	842

Note. For the fixed part of the models, separate intercepts for controls and footballers at baseline are displayed. Separate estimates of changes across time for controls and footballers are displayed. Changes across time relates to per occasion change. * indicates baseline differences between controls and footballers at $p<0.05$. Effect sizes (*d*) for comparison between controls and footballers at baseline are displayed as a = small (0.20-0.49), b = medium (0.50-0.79), and c = large (>0.79). #indicates changes across time for a given group, at $p<0.05$. For the random part of the models, random intercept for controls at baseline is the estimated inter-individual variation in intercepts for controls, presented as standard deviations. Random intercept for footballers at baseline is the estimated inter-individual variation in intercepts for footballers, presented as standard deviations. The residual variance is the estimated within-individual variation presented as standard deviations. Final -2LL is the -2 loglikelihood for the final model. pQCT = peripheral Quantitative Computed Tomography, SSIPOL = Polar stress strain index, SSIX = X stress strain index, SSIY = Y stress strain index.