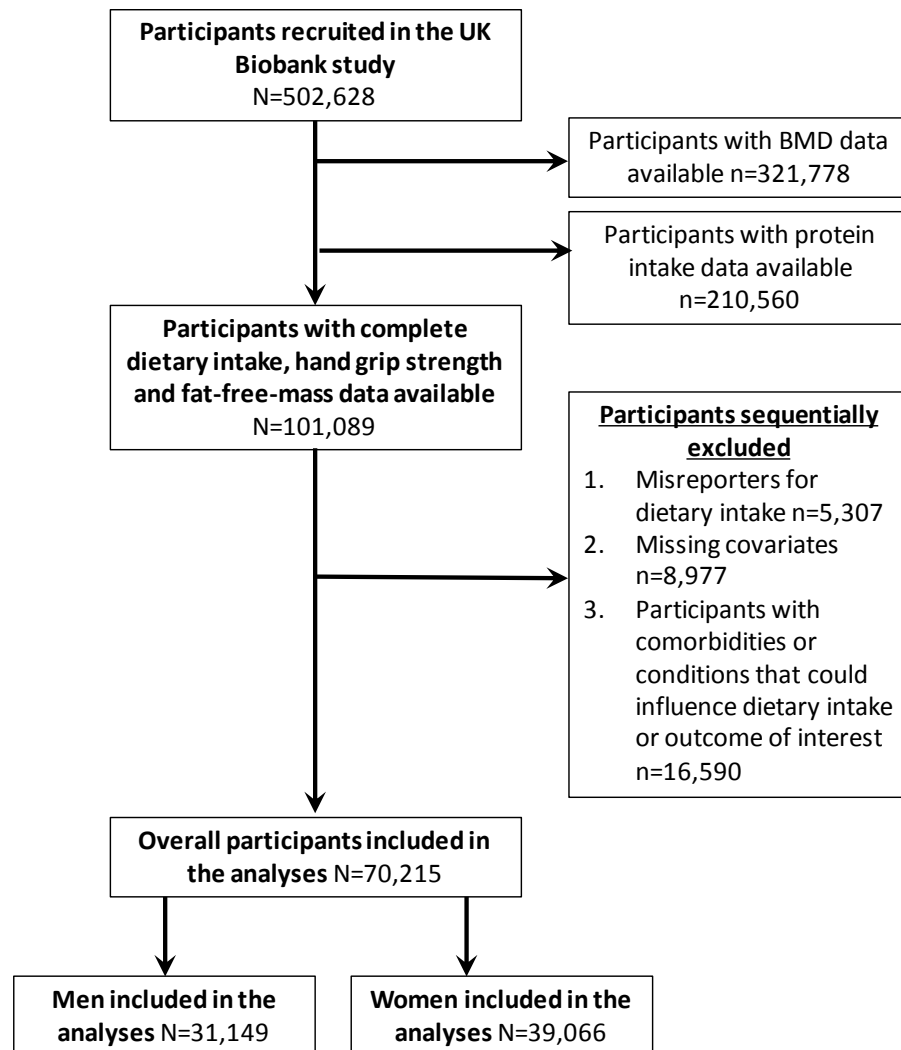
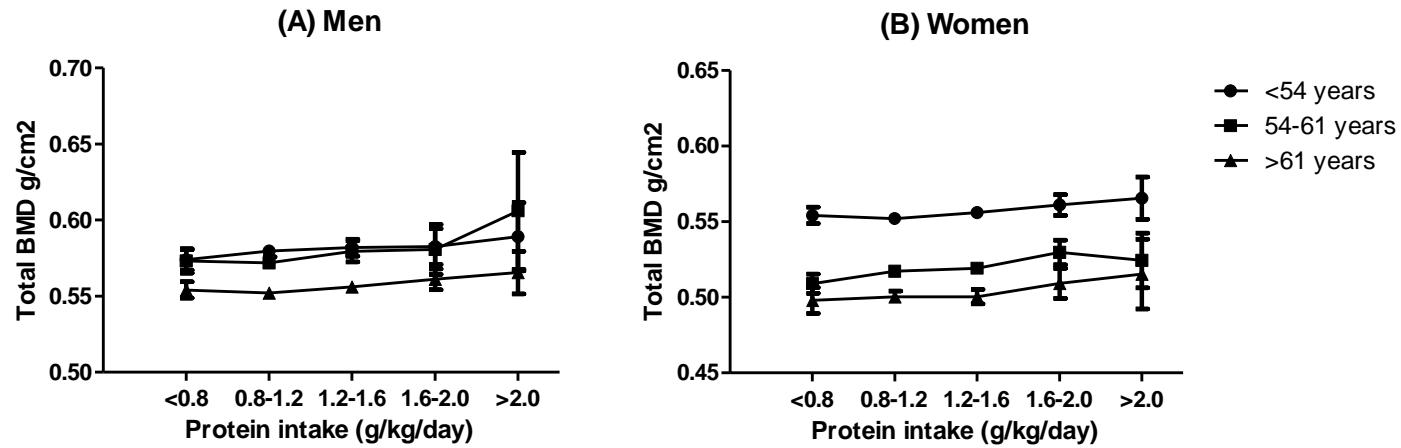


Supplementary Figure S1. Study participant flow chart



Supplementary Figure S2 Heel BMD by protein intake in men (A) and women (B) stratified by age



Data presented as adjusted mean and their 95%CI. Analyses were adjusted for ethnicity, Townsend score, smoking, body weight, physical activity, sedentary behaviours, total energy intake, alcohol intake, fruit and veg intake, calcium intake and potassium intake.

Table S1 Cohort descriptive characteristics by reported protein intake categories in men

	Category of Daily Protein Intake (g.kg ⁻¹ .day ⁻¹)					
	Overall	<0.8	0.8 – 1.2	1.2 – 1.6	1.6 – 2.0	>2.0
Socio-demographics						
Total, n	31149	5739	16297	7409	1412	292
Age (years)	56.0 (7.9)	55.9 (7.8)	56.3 (7.8)	55.7 (8.1)	54.7 (8.1)	52.8 (8.2)
Ethnicity, n (%)						
White	30456 (97.8)	5615 (97.8)	16018 (98.3)	7211 (97.3)	1348 (95.5)	264 (90.4)
Black	165 (0.5)	25 (0.4)	69 (0.4)	49 (0.7)	13 (0.9)	9 (3.1)
South Asian	218 (0.7)	43 (0.8)	92 (0.6)	61 (0.8)	15 (1.1)	7 (2.4)
Chinese	55 (0.2)	4 (0.1)	14 (0.1)	19 (0.3)	15 (1.1)	3 (1.0)
Mixed background	113 (0.4)	26 (0.5)	48 (0.3)	27 (0.4)	10 (0.7)	2 (0.7)
Other	142 (0.5)	26 (0.5)	56 (0.3)	42 (0.6)	11 (0.8)	7 (2.4)
Deprivation Index	-1.98 (2.85)	-1.80 (2.92)	-2.09 (2.79)	-2.00 (2.85)	-1.64 (3.08)	-1.27 (3.29)
Deprivation, n (%)						
1 (Least Deprived)	10278 (33.0)	1744 (30.4)	5570 (34.2)	2468 (33.3)	419 (29.7)	77 (26.4)
2	8430 (27.1)	1536 (26.8)	4447 (27.3)	1991 (26.9)	381 (27.0)	75 (25.7)
3	6974 (22.4)	1331 (23.2)	3613 (22.2)	1656 (22.4)	306 (21.7)	68 (23.3)
4 (Most Deprived)	5467 (17.6)	1128 (19.7)	2667 (16.4)	1294 (17.5)	306 (21.7)	72 (24.7)
Smoking Status, n (%)						
Never	16981 (54.5)	2923 (50.9)	8761 (53.8)	4301 (58.1)	823 (58.3)	173 (59.3)
Former	11632 (37.3)	2298 (40.0)	6262 (38.4)	2522 (34.0)	457 (32.4)	93 (31.9)
Current	2536 (8.1)	518 (9.0)	1274 (7.8)	586 (7.9)	132 (9.4)	26 (8.9)
Body Composition & Physical Activity						
Body weight	84.1 (12.8)	91.5 (14.5)	84.7 (11.6)	78.8 (10.7)	76.3 (11.1)	75.1 (12.5)
Heel BMD (g.cm ⁻²)	0.576 (0.139)	0.583 (0.147)	0.575 (0.137)	0.573 (0.136)	0.574 (0.138)	0.579 (0.151)
Total Sedentary Time (hours.day ⁻¹)	5.3 (2.3)	5.6 (2.4)	5.3 (2.2)	5.1 (2.2)	5.0 (2.3)	5.1 (2.2)
Total PA (MET-mins.wk ⁻¹)	2501.1 (3261.7)	2350.1 (3462.0)	2395.9 (3030.0)	2702.0 (3365.9)	3012.4 (3711.7)	3769.6 (5299.9)
Handgrip strength (kg)	41.2 (8.2)	41.5 (8.3)	41.3 (8.2)	40.7 (8.1)	40.4 (8.3)	40.7 (8.8)
Dietary Intake						
Total energy intake (kcal.day ⁻¹)	2378.6 (562.8)	1965.3 (398.7)	2296.9 (450.8)	2701.6 (534.3)	3099.4 (611.8)	3385.8 (606.4)
Fruit & vegetable intake (portions.day ⁻¹)	3.9 (2.3)	3.8 (2.3)	3.9 (2.2)	3.9 (2.2)	4.1 (2.5)	4.2 (2.8)
Alcohol intake (g.day ⁻¹)	2.4 (1.3)	2.5 (1.4)	2.4 (1.3)	2.4 (1.3)	2.6 (1.4)	2.7 (1.4)

Protein Intake (% of TE)	15.0 (3.1)	12.8 (2.7)	15.0 (2.7)	16.1 (2.9)	17.6 (3.6)	20.3 (4.2)
Fat Intake (% of TE)	32.1 (6.3)	30.7 (7.0)	32.0 (6.1)	32.8 (6.0)	33.7 (6.4)	34.4 (6.4)
Carbohydrate Intake (% of TE)	46.5 (7.8)	48.5 (8.5)	46.5 (7.4)	45.6 (7.4)	44.1 (8.0)	40.5 (8.6)
Calcium Intake (mg.day ⁻¹)	1025.3 (344.4)	818.8 (243.7)	987.9 (283.0)	1184.9 (367.6)	1384.5 (464.8)	1388.6 (476.1)
Potassium Intake (mg.day ⁻¹)	3928.6 (1093.5)	3172.2 (805.2)	3796.0 (865.2)	4481.6 (1084.5)	5247.4 (1377.8)	5783.2 (1481.1)

Data presented as mean (SD) or % (n) for continuous and categorical variables as appropriate. TE: total energy intake; SD: standard deviation; MET: metabolic equivalent; BMD: bone mineral density.

Table S2 Cohort descriptive characteristics by reported protein intake categories in women

	Category of Daily Protein Intake (g.kg ⁻¹ .day ⁻¹)					
	Overall	<0.8	0.8 – 1.2	1.2 – 1.6	1.6 – 2.0	>2.0
Socio-demographics						
Total, n	39066	5382	17727	12315	3069	573
Age (years)	54.6 (7.6)	54.1 (7.6)	54.7 (7.6)	54.9 (7.6)	54.4 (7.9)	53.1 (8.0)
Ethnicity, n (%)						
White	38181 (97.7)	5223 (97.1)	17391 (98.1)	12062 (98.0)	2983 (97.2)	522 (91.1)
Black	199 (0.5)	52 (1.0)	78 (0.4)	42 (0.3)	13 (0.4)	14 (2.4)
South Asian	181 (0.5)	36 (0.7)	79 (0.5)	43 (0.4)	17 (0.5)	6 (1.1)
Chinese	104 (0.3)	6 (0.1)	27 (0.2)	37 (0.3)	17 (0.5)	17 (3.0)
Mixed background	195 (0.5)	33 (0.6)	76 (0.4)	65 (0.5)	14 (0.5)	7 (1.2)
Other	206 (0.5)	32 (0.6)	76 (0.4)	66 (0.5)	25 (0.8)	7 (1.2)
Deprivation Index	-1.88 (2.85)	-1.48 (3.06)	-1.83 (2.88)	-2.10 (2.71)	-2.02 (2.81)	-1.86 (2.95)
Deprivation, n (%)						
1 (Least Deprived)	12181 (31.2)	1447 (26.9)	5415 (30.5)	4104 (33.3)	1029 (33.5)	186 (32.6)
2	10624 (27.2)	1418 (26.4)	4767 (26.9)	3478 (28.2)	818 (26.6)	143 (25.0)
3	9046 (23.2)	1263 (23.5)	4195 (23.7)	2763 (22.4)	687 (22.4)	138 (24.1)
4 (Most Deprived)	7215 (18.5)	1254 (23.3)	3350 (18.9)	1970 (16.0)	535 (17.4)	106 (18.5)
Smoking Status, n (%)						
Never	24510 (62.7)	3152 (58.6)	10905 (65.4)	8053 (65.4)	2017 (65.7)	383 (66.8)
Former	12273 (31.4)	1819 (33.8)	5796 (32.7)	3606 (29.3)	899 (29.3)	153 (26.7)
Current	2283 (5.8)	411 (7.6)	1026 (5.8)	656 (5.3)	153 (5.0)	37 (6.5)
Body Composition & Physical Activity						
Body weight	69.7 (13.0)	79.7 (16.4)	71.8 (12.2)	65.0 (9.3)	60.9 (8.6)	58.5 (9.2)
Heel BMD (g.cm ⁻²)	0.530 (0.120)	0.536 (0.121)	0.530 (0.118)	0.527 (0.119)	0.532 (0.126)	0.537 (0.135)
Total Sedentary Time (hours.day ⁻¹)	4.5 (1.9)	4.8 (2.1)	4.6 (1.9)	4.4 (1.8)	4.3 (1.8)	4.2 (2.0)
Total PA (MET-mins.wk ⁻¹)	2220.8 (2710.8)	2034.3 (2685.9)	2170.9 (2750.9)	2314.1 (2673.2)	2397.5 (2575.8)	2562.9 (3034.6)
Handgrip strength (kg)	25.1 (6.0)	25.4 (6.2)	25.1 (6.0)	24.9 (5.9)	24.8 (5.9)	24.1 (6.1)
Dietary Intake						
Total energy Intake (kcal.day ⁻¹)	2002.9 (471.9)	1619.5 (375.6)	1906.5 (406.5)	2176.3 (425.6)	2427.8 (444.2)	2584.5 (425.6)
Fruit & vegetable Intake (portions.day ⁻¹)	4.5 (2.2)	4.4 (2.5)	4.4 (2.2)	4.5 (2.1)	4.6 (2.3)	4.8 (2.5)
Alcohol Intake (g.day ⁻¹)	2.9 (1.4)	3.1 (1.5)	2.9 (1.4)	2.8 (1.4)	2.9 (1.4)	3.0 (1.5)
Protein Intake (% of TE)	15.9 (3.5)	13.4 (3.1)	15.6 (3.2)	16.7 (3.2)	17.9 (3.4)	20.5 (4.6)
Fat Intake (% of TE)	32.5 (6.5)	31.9 (7.2)	32.3 (6.5)	32.8 (6.1)	33.1 (6.4)	33.1 (6.7)
Carbohydrate Intake (% of TE)	47.4 (7.7)	50.0 (8.4)	47.7 (7.5)	46.5 (7.3)	45.5 (7.6)	43.0 (9.0)

Calcium Intake (mg.day ⁻¹)	940.3 (309.8)	735.5 (233.1)	889.0 (264.8)	1029.8 (300.1)	1179.1 (361.9)	1252.4 (420.1)
Potassium Intake (mg.day ⁻¹)	3648.7 (998.2)	2868.0 (817.7)	3466.0 (839.3)	3986.9 (920.4)	4487.3 (1056.9)	4872.9 (1096.2)

Data presented as mean (SD) or % (n) for continuous and categorical variables as appropriate. TE: total energy intake; SD: standard deviation; MET: metabolic equivalent; BMD: bone mineral density.

Supplementary Table S3 Association between protein intake and BMD, including participants with co-morbidities

Men	Total N	β-coefficient (95%CI)	p-value
Model 0	38,482	-0.010 (-0.015;-0.006)	<0.0001
Model 1	38,482	-0.011 (-0.016;-0.007)	<0.0001
Model 2	38,482	0.009 (0.002; 0.016)	0.009
Women			
Model 0	48,323	-0.005 (-0.008;-0.002)	0.001
Model 1	48,323	-0.006 (-0.009;-0.003)	<0.0001
Model 2	48,323	0.010 (0.004; 0.015)	<0.0001

Model 0 = unadjusted

Model 1 = adjusted for age, sex, ethnicity and Townsend score

Model 2 = model 1 + adjusted for smoking, comorbidities, body weight, physical activity, grip strength, sedentary behaviours, total energy intake, alcohol intake and fruit and veg intake.

Supplementary Table S4. Association between protein intake and BMD by tertiles of age.

Men	Total N	β-coefficient (95%CI)	p-value
<54 years	11,504	0.010 (-0.001; 0.021)	0.082
54-61 years	10,644	0.004 (-0.010; 0.017)	0.563
>61 years	9,001	0.009 (-0.006; 0.024)	0.253
Women			
<54 years	17,146	0.008 (0.000; 0.016)	0.030
54-61 years	13,470	0.014 (0.005; 0.023)	0.003
>61 years	8,450	0.012 (0.000; 0.024)	0.044

Adjusted for age, sex, ethnicity, Townsend score, smoking, BMI, physical activity, handgrip strength, sedentary behaviours, total energy intake, alcohol intake and fruit and veg intake