

**Table S1.** Descriptive statistics of VitD metabolites by sex.

Characteristics	All participants n=1,853	Women n=1289	Men n=565	<i>P</i> value
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	21.1(20.8-21.5)	20.8(20.4-21.2)	21.9(21.3-22.5)	0.040
Vitamin D-binding protein (μmol/l) <sup>a</sup>	271.5(268.0-275.0)	275.1(270.9-279.3)	263.2(256.9-269.5)	0.001
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	5.9(5.7-6.0)	5.7(5.6-5.8)	6.2(6.0-6.5)	0.001
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	2.2(2.2-2.3)	2.1(2.0-2.2)	2.4(2.3-2.5)	<0.001
Free 25-hydroxivitamin D-SNP adjusted (pg/mL) <sup>a</sup>	6.7(6.5-6.9)	6.5(6.3-6.7)	7.2(6.9-7.5)	<0.001
Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL) <sup>a</sup>	2.5(2.5-2.6)	2.4(2.3-2.5)	2.7(2.6-2.8)	<0.001

<sup>a</sup> Adjusted median (95% CI). Median adjusted by age groups, BMI (normal, overweight, obesity), leisure time physical activity (active >150 min/week), vitamin D intake (quartiles) and smoking (never, smoking, former smoker).

**Table S2.** Factors associated with VDBP levels in all participants.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>h</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>h</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.6*</b> (-0.9,-0.4)	<b>-0.5*</b> (-0.7,-0.3)	<b>-0.3*</b> (-0.6,-0.1)	-0.1 (-0.4,0.2)	<b>-0.5*</b> (-0.9,-0.02)	<b>-0.6*</b> (-0.9,-0.2)	<b>-0.7*</b> (-1.0,-0.4)	<b>-0.5*</b> (-0.8,-0.2)	-0.2 (-0.6,0.2)	-0.2 (-0.8,0.3)
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	-1.5 (-10.7,7.6)	6.9 (-0.6,14.5)	<b>11.6*</b> ( <b>3.9,19.3</b> )	<b>15.0*</b> ( <b>5.9,24.1</b> )	<b>18.8*</b> ( <b>4.2,33.3</b> )	9.1 (-1.46,19.7)	8.7 (-1.0,18.4)	<b>13.1*</b> ( <b>3.4,22.8</b> )	<b>15.0*</b> ( <b>2.2,27.8</b> )	<b>19.5*</b> ( <b>2.7,36.3</b> )
Smoking status	<b>-22.4*</b> ( <b>-32.4,-12.4</b> )	<b>-12.2*</b> ( <b>-22.3,-2.2</b> )	-7.5 (-16.9,1.8)	-7.5 (-17.6,2.7)	<b>-23.1*</b> ( <b>-37.0,-9.3</b> )	-7.3 (-19.2,4.5)	3.5 (-7.4,14.4)	1.6 (-9.3,12.4)	-0.6 (-14.9,13.8)	-5.9 (-24.8,12.9)
Normal										
Current	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Past	1.6 (-7.4,10.5)	-2.5 (-9.9,4.9)	-6.11 (-13.6,1.33)	-1.11 (-9.9,7.7)	-8.9 (-24.6,6.8)	0.11 (-8.1,8.3)	-4.6 (-12.1,3.0)	-7.1 (-14.6,0.4)	-4.2 (-14.2,5.7)	-8.3 (-21.3,4.8)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.1 (-15.1,11.0)	-2.3 (-13.5,8.8)	-10.1 (-21.1,0.8)	-2.5 (-16.2,11.1)	-14.4 (-35.5,6.6)	-1.1 (-13.3,11.2)	-8.0 (-19.3,3.2)	-6.4 (-17.6,4.8)	1.2 (-13.6,16.1)	-4.8 (-24.3,14.6)
Obesity	-2.5 (-12.1,7.0)	0.5 (-7.6,8.6)	-0.07 (-8.1,8.0)	2.9 (-7.1,12.9)	3.2 (-12.2,18.5)	-2.4 (-11.2,6.5)	1.6 (-6.6,9.7)	3.1 (-5.0,11.3)	5.1 (-5.6,15.9)	7.4 (-6.7,21.6)
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>										
Vitamin D intake (UI/day) <sup>a</sup>	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol(g/day) <sup>a</sup>	-4.3 (-13.7,5.0)	-8.1 (-15.5,-0.6)	-7.3 (-15.5,0.9)	-3.3 (-12.9,6.2)	-12.5 (-27.5,2.4)	-1.81 (-10.6,7.0)	-4.5 (-12.6,3.6)	0.6 (-7.4,8.7)	-1.6 (-12.3,9.1)	-7.2 (-21.2,6.7)
rs4588	-6.5 (-17.3,4.3)	-5.9 (-14.5,2.8)	-3.7 (-13.1,5.7)	-5.9 (-17.0,5.2)	-5.6 (-22.9,11.8)	-9.2 (-19.4,1.1)	-7.0 (-16.5,2.4)	0.8 (-8.6,10.2)	-3.0 (-15.5,9.4)	-9.2 (-25.5,7.2)
CC	0.5 (-0.1,1.1)	0.4 (-0.1,0.9)	0.1 (-0.4,0.6)	-0.3 (-0.9,0.3)	<b>-1.3*</b> ( <b>-2.3,-0.3</b> )	0.4 (-0.2,1.0)	0.3 (-16.5,2.4)	0.04 (-0.5,0.6)	-0.7 (-1.4,0.004)	<b>-1.1*</b> ( <b>-2.1,-0.2</b> )
CA+AA	-0.0001 (-0.02,0.02)	-0.001 (-0.02,0.02)	-0.002 (-0.02,0.02)	-0.008 (-0.03,0.02)	-0.002 (-0.04,0.04)	-0.003 (-0.02,0.02)	-0.007 (-0.03,0.01)	0.002 (-0.02,0.02)	0.005 (-0.02,0.03)	-0.002 (-0.04,0.03)
rs7041	0.05 (-0.20,0.30)	0.02 (-0.19,0.22)	-0.05 (-0.26,0.16)	-0.10 (-0.35,0.16)	-0.004 (-0.43,0.42)	0.05 (-0.2,0.3)	-0.008 (-0.22,0.20)	-0.03 (-0.24,0.18)	0.23 (-0.04,0.51)	0.22 (-0.14,0.58)
TT										
TG	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
GG	<b>-8.6*</b> ( <b>-16.2,-1.0</b> )	<b>-16.7*</b> ( <b>-22.8,-10.6</b> )	<b>-20.3*</b> ( <b>-26.1,-14.4</b> )	<b>-16.5*</b> ( <b>-23.5,-9.5</b> )	<b>-17.2*</b> ( <b>-29.1,-5.3</b> )	<b>-9.9*</b> ( <b>-17.6,-2.2</b> )	<b>-14.9*</b> ( <b>-21.9,-7.8</b> )	<b>-18.3*</b> ( <b>-25.4,-11.3</b> )	<b>-15.7*</b> ( <b>-25.0,-6.4</b> )	-9.1 (-21.3,3.1)
Age(years)										
Leisure time physical activity	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Inactive (<30 min/day)	2.9 (-7.3,13.0)	<b>10.8*</b> ( <b>2.3,19.2</b> )	<b>15.3*</b> ( <b>7.4,23.2</b> )	<b>15.6*</b> ( <b>6.0,25.3</b> )	<b>17.3*</b> ( <b>2.3,32.3</b> )	0.8 (-8.4,10.0)	7.7 (-0.8,16.2)	7.1 (-1.3,15.6)	9.5 (-1.7,20.7)	7.0 (-7.7,21.7)
Active (≥30 min/day)	5.9 (-6.2,17.9)	<b>11.7*</b> ( <b>1.7,21.7</b> )	<b>22.2*</b> ( <b>12.8,31.6</b> )	<b>22.1*</b> ( <b>10.6,33.6</b> )	<b>32.7*</b> ( <b>14.8,50.5</b> )	-2.8 (-14.6,9.0)	1.4 (-9.4,12.3)	7.5 (-3.4,18.3)	12.0 (-2.3,26.3)	15.8 (-3.0,34.6)

\*P value <0.05

**Table S3.** Factors associated with VDBP levels in all men.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.4*</b> (-0.8,-0.02)	<b>-0.4*</b> (-0.7,0.02)	<b>-0.2</b> (-0.7,0.2)	0.4 (-0.2,0.9)	0.3 (-0.5,1.2)	-0.4 (-0.8,0.01)	<b>-0.5*</b> (-0.8,-0.1)	-0.05 (-0.5,0.3)	0.2 (-0.4,0.8)	0.6 (-0.2,1.3)
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	0.4 (-13.0,13.8)	2.2 (-9.1,13.5)	-4.5 (-17.7,8.6)	-6.1 (-22.8,10.6)	-8.0 (-29.2,13.3)	2.7 (-10.0,15.4)	-3.0 (-14.2,8.2)	-1.9 (-13.8,10.1)	-5.5 (-23.6,12.6)	-6.4 (-28.5,15.7)
Smoking status										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Current	7.7 (-10.5,25.9)	-1.9 (-12.7,16.6)	3.4 (-13.7,20.4)	2.5 (-19.1,24.2)	6.4 (-22.1,35.0)	-1.3 (-17.9,15.2)	1.4 (-13.2,16.0)	5.9 (-9.6,21.5)	4.5 (-19.0,28.1)	13.4 (-15.3,42.1)
Past	-8.5 (-23.7,6.7)	-1.5 (-13.7,10.7)	9.3 (-5.0,23.6)	12.0 (-6.1,30.2)	<b>24.4*</b> (0.5,48.3)	-7.2 (-21.1,6.8)	2.3 (-10.0,14.6)	7.6 (-5.5,20.8)	8.4 (-11.5,28.3)	31.0 (6.7,55.2)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	3.9 (-8.6,16.4)	-3.4 (-15.3,8.5)	<b>-15.5*</b> (-28.4,-2.7)	-13.2 (-31.2,4.9)	-6.0 (-35.0,23.1)	3.7 (-10.1,17.6)	-3.5 (-15.7,8.7)	-11.4 (-24.4,1.6)	-11.0 (-30.7,8.8)	-18.6 (-42.7,5.5)
Obesity	-12.2 (-28.2,3.8)	-15.6 (-30.8,-0.4)	-11.9 (-28.3,4.6)	-20.7 (-43.8,2.3)	-16.2 (-53.4,20.9)	-13.1 (-30.9,4.6)	<b>-21.8*</b> (-37.4,-6.1)	-12.8 (-29.5,3.9)	-23.0 (-48.3,2.3)	-33.0 (63.9,-2.1)
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	0.3 (-0.7,1.3)	0.1 (-0.6,0.9)	0.2 (-0.8,1.1)	-0.5 (-1.6,0.7)	-0.5 (-2.2,1.1)	0.2 (-0.7,1.1)	-0.2 (-1.0,0.6)	-0.4 (-1.3,0.5)	-0.9 (-2.3,0.4)	-0.9 (-2.5,0.7)
Vitamin D intake (UI/day) <sup>a</sup>	-0.0004 (-0.03,0.03)	0.001 (-0.02,0.03)	0.01 (-0.02,0.04)	0.02 (-0.02,0.05)	0.002 (-0.05,0.05)	-0.003 (-0.03,0.03)	-0.006 (-0.03,0.02)	0.009 (-0.02,0.04)	0.02 (-0.02,0.06)	0.004 (-0.05,0.05)
Alcohol(g/day) <sup>a</sup>	0.003 (-0.23,0.24)	0.02 (-0.17,0.21)	-0.04 (-0.27,0.19)	0.25 (-0.05,0.55)	0.30 (-0.08,0.67)	0.05 (-0.16,0.26)	0.02 (-0.17,0.20)	-0.04 (-0.24,0.16)	-0.02 (-0.32,0.28)	0.07 (-0.29,0.44)
rs4588										
CC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
CA+AA	<b>-11.1*</b> (-22.0,-0.19)	-7.6 (-17.5,2-4)	<b>-17.5*</b> (-28.0,-6.9)	-12.5 (-28.3,3.4)	-9.9 (-31.6,11.8)	-9.0 (-21.9,3.9)	-10.1 (-21.5,1.3)	-11.2 (-23.4,0.9)	-14.6 (-33.0,3.8)	-13.4 (-35.9,9.0)
rs7041										
TT	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
TG	2.9 (-12.1,18.0)	4.9 (-8.3,18.1)	<b>20.1*</b> (6.1,34.2)	16.1 (-4.0,36.3)	12.6 (-20.7,45.9)	4.5 (-11.0,19.9)	4.0 (-9.6,17.6)	12.5 (-2.0,27.1)	15.9 (-6.2,37.9)	13.2 (-13.6,40.1)
GG	9.4 (-8.8,27.7)	6.3 (-9.7,22.3)	<b>25.3*</b> (8.3,42.3)	18.6 (-5.9,43.0)	16.7 (-23.6,57.1)	2.7 (-17.4,22.7)	4.1 (13.6,21.8)	<b>19.9*</b> (1.0,38.8)	14.9 (-13.7,43.5)	19.5 (-15.4,54.5)

\*P value <0.05

**Table S4.** Factors associated with VDBP levels in all women.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.8*</b> (-1.1,-0.5)	<b>-0.7*</b> (-1.0,-0.4)	<b>-0.6*</b> (-0.8,-0.3)	<b>-0.4*</b> (-0.7,-0.03)	<b>-0.9*</b> (-1.4,-0.4)	<b>-0.76*</b> (-1.3,-0.2)	<b>-0.7*</b> (-1.2,0.2)	<b>-1.0*</b> (-1.4,-0.5)	<b>-0.6*</b> (-1.2,-0.1)	<b>-1.3*</b> (-2.0,0.7)
Leisure time physical activity	<b>-16.1*</b> (-25.9,-6.3)	-8.6 (-18.4,1.3)	-5.8 (-14.9,3.3)	-6.4 (-16.4,3.4)	<b>-23.1*</b> (-36.8,-9.4)	-3.8 (-19.5,11.9)	6.4 (-7.8,20.7)	12.4 (-0.4,25.3)	6.0 (-11.1,23.1)	12.9 (-6.8,32.6)
Inactive (<30 min/day)										
Active (≥30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Smoking status	0.4 (-12.3,13.1)	-6.5 (-16.8,3.8)	-6.0 (-15.8,3.8)	1.1 (-8.8,11.1)	-6.6 (-25.2,12.0)	0.9 (-10.4,12.2)	-4.2 (-14.4,6.1)	-6.1 (-15.3,3.1)	-1.5 (-13.7,10.8)	-3.2 (-17.4,10.9)
Normal										
Current	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Past	-7.0 (-27.7,13.7)	-1.7 (-19.5,16.1)	-14.2 (-30.4,2.0)	-2.3 (-19.9,15.3)	-12.6 (-41.2,16.0)	-2.2 (-21.3,16.9)	-8.8 (-25.9,8.9)	-17.5 (-33.1,1.8)	-1.6 (-22.5,19.2)	2.4 (-21.6,26.4)
BMI (kg/m <sup>2</sup> )	-0.4 (-14.0,13.2)	1.1 (-10.5,12.8)	0.9 (-9.7,11.5)	2.6 (-8.9,14.2)	-4.0 (-22.7,14.8)	0.5 (-11.8,12.9)	1.6 (-9.6,12.9)	-1.0 (-11.9,9.1)	1.3 (-12.1,14.8)	-3.2 (-17.4,10.9)
Normal										
Overweight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Obesity	-11.2 (-23.5,1.0)	-10.7 (-21.4,0.01)	-3.9 (-14.4,6.7)	-0.5 (-11.5,10.5)	-15.3 (-32.9,2.3)	-5.3 (-17.4,6.7)	-4.6 (-15.6,6.4)	2.7 (-7.2,12.6)	3.9 (-9.3,17.0)	5.6 (-9.6,20.7)
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	-3.8 (-17.4,9.8)	-2.2 (-14.1,9.7)	-0.4 (-12.1,11.4)	0.9 (-11.3,13.2)	-7.9 (-27.5,11.7)	-5.8 (-19.3,7.7)	-3.0 (-15.3,9.3)	1.5 (-9.5,12.6)	7.8 (-6.9,22.5)	3.5 (-13.5,20.4)
Vitamin D intake (UI/day) <sup>a</sup>	0.7 (-0.04,1.4)	0.6 (-0.9,1.3)	0.3 (-0.4,1.0)	-0.3 (-1.1,0.4)	<b>-1.5*</b> (-2.7,-0.3)	0.5 (-0.4,1.3)	0.4 (-0.4,1.1)	0.08 (-0.6,0.7)	-0.5 (-1.3,0.4)	-1.2 (-2.3,-0.2)
Alcohol(g/day) <sup>a</sup>	0.004 (-0.03,0.04)	-0.01 (-0.04,0.02)	-0.003 (-0.03,0.03)	-0.02 (-0.05,0.01)	-0.03 (-0.09,0.02)	0.02 (-0.009,0.06)	-0.007 (-0.04,0.02)	-0.01 (-0.04,0.01)	-0.02 (-0.05,0.02)	-0.009 (-0.05,0.03)
rs4588	0.07 (-1.2,1.3)	0.1 (-1.0,1.2)	-0.1 (-1.1,0.8)	-0.2 (-1.2,0.9)	-0.3 (-2.1,1.6)	0.3 (-0.9,1.4)	0.13 (-0.9,1.2)	0.4 (-0.5,1.4)	-0.5 (-1.7,0.8)	-0.45 (-1.9,1.0)
CC										
CA+AA	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
rs7041	-8.4 (-19.4,2.6)	<b>-20.4*</b> (-27.9,-12.9)	<b>-19.4*</b> (-27.1,-11.7)	<b>-15.7*</b> (-24.4,-6.9)	<b>-19.2*</b> (-33.4,5.0)	<b>-10.8*</b> (-21.0,-0.6)	<b>-17.5*</b> (-26.7,-8.2)	<b>-18.7*</b> (-27.0,-10.3)	<b>-12.8*</b> (-23.9,-1.7)	<b>-13.6*</b> (-26.5,-0.82)
TT										
TG	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
GG	1.9 (-10.8,14.6)	<b>12.9*</b> (2.2,23.6)	<b>14.4*</b> (4.5,24.4)	<b>12.3*</b> (0.6,24.1)	14.0 (-3.4,31.4)	-5.1 (-17.4,7.2)	5.5 (-5.7,16.7)	5.8 (-4.3,15.9)	10.0 (-3.4,23.4)	2.4 (-13.1,17.8)
Age(years)	0.1 (-14.9,15.1)	<b>13.9*</b> (1.3,26.5)	<b>21.5*</b> (9.8,33.2)	<b>20.5*</b> (6.7,34.4)	<b>32.1*</b> (11.6,53.6)	-10.9 (-26.5,4.6)	-2.2 (-16.4,11.9)	6.7 (-6.0,19.4)	14.4 (-2.5,31.4)	18.1 (-1.5,37.6)

\*P value &lt;0.05

**Table S5.** Factors associated with VDBP levels in premenopausal women.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.9*</b> (-1.5,0.2)	<b>-0.9*</b> (-1.5,-0.3)	<b>-0.9*</b> (-1.5,-0.3)	0.03 (-0.8,0.9)	-0.4 (-1.3,0.6)	<b>-1.0*</b> (-1.7,-0.2)	<b>-0.7*</b> (-1.3,-0.1)	<b>-0.07*</b> (-1.3,-0.1)	-0.3 (-1.0,0.6)	-0.2 (-1.3,0.9)
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	-0.9 (-17.3,15.6)	2.9 (-12.7,18.5)	1.8 (-13.8,17.4)	2.7 (-16.1,21.5)	8.7 (-14.3,31.8)	-1.8 (-20.0,16.3)	2.7 (-12.1,17.5)	5.6 (-8.8,19.9)	1.01 (-18.2,20.2)	-3.4 (-29.9,23.1)
Smoking status										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Current	-6.0 (-28.2,16.2)	-1.1 (-18.7,16.4)	7.9 (-9.2,24.9)	3.2 (-17.1,23.5)	4.2 (-23.9,32.3)	-8.4 (-38.4,21.6)	-12.4 (-36.9,11.9)	-19.9 (-18.6,14.2)	13.6 (-18.1,45.3)	11.0 (-32.7,54.8)
Past	4.8 (-24.8,34.4)	-3.8 (-27.3,19.7)	-11.1 (-34.0,11.6)	18.5 (-8.6,45.6)	-16.2 (-53.8,21.3)	-7.5 (-28.3,13.4)	-6.0 (-23.0,10.9)	-2.2 (-43.5,3.8)	-5.4 (-27.4,16.6)	-1.5 (-31.9,28.9)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	0.9 (-15.3,17.1)	-7.4 (-21.4,6.5)	-14.8 (-30.5,0.9)	-7.8 (-28.9,13.3)	-27.4* (-52.1,-2.7)	3.7 (-15.7,23.1)	-3.8 (-19.6,12.0)	-1.3 (-16.6,14.0)	-5.8 (-26.3,14.7)	-26.2 (-54.5,2.0)
Obesity	-17.1 (-36.2,2.1)	<b>-20.7*</b> (-37.2,-4.2)	<b>-23.4*</b> (-42.0,-4.8)	0.8 (-24.2,25.8)	-5.3 (-34.5,24.0)	-3.6 (-26.4,19.2)	-9.1 (-27.7,9.4)	-16.0 (-34.0,2.0)	0.7 (-23.4,24.8)	-8.7 (-41.9,24.6)
Total 25-hydroxyvitamin D (ng/mL) <sup>a</sup>	0.6 (-0.6,1.9)	0.6 (-0.5,1.7)	-0.1 (-1.3,1.0)	-0.9 (-2.4,0.6)	<b>-1.9*</b> (-3.5,-0.3)	0.6 (-0.7,2.0)	0.2 (-1.0,1.3)	0.05 (-1.0,1.1)	<b>-1.9*</b> (-3.3,-0.4)	<b>-2.5*</b> (-4.5,-0.5)
Vitamin D intake (UI/day) <sup>a</sup>	-0.04 (-0.10,0.02)	-0.01 (-0.06,0.04)	0.002 (-0.05,0.05)	-0.03 (-0.09,0.03)	-0.04 (-0.12,0.03)	-0.03 (-0.09,0.03)	-0.01 (-0.05,0.04)	-0.03 (-0.07,0.02)	-0.03 (-0.1,0.03)	-0.08 (-0.16,0.01)
Alcohol(g/day) <sup>a</sup>	0.5 (-1.2,2.2)	0.7 (-0.8,2.2)	0.1 (-1.5,1.6)	0.6 (-1.3,2.4)	-0.02 (-2.4,2.4)	1.2 (-0.7,3.1)	1.3 (-0.3,2.8)	1.2 (-0.3,2.7)	0.9 (-1.1,2.9)	1.0 (-1.8,3.7)
rs4588										
CC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
CA+AA	<b>-18.0*</b> (-33.8,-2.1)	<b>-23.6*</b> (-35.1,-12.1)	<b>-22.7*</b> (-35.0,-10.3)	-16.0 (-33.5,1.6)	-6.7 (-26.6,13.2)	-15.1 (-32.1,1.9)	<b>-19.4*</b> (-33.2,-5.6)	<b>-19.3*</b> (-32.7,-5.9)	-13.8 (-31.8,4.2)	-3.1 (-27.9,21.7)
rs7041										
TT	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
TG	4.3 (-15.6,24.1)	<b>17.0*</b> (1.3,32.6)	<b>24.3*</b> (7.3,41.3)	<b>23.0*</b> (2.1,43.9)	<b>37.3*</b> (12.3,62.2)	-2.2 (-22.3,17.9)	7.9 (-8.5,24.3)	10.2 (-5.6,26.1)	19.6 (-1.7,40.9)	<b>32.3*</b> (3.0,61.7)
GG	10.8 (-13.5,35.2)	<b>19.3*</b> (0.1,38.5)	<b>31.8*</b> (10.8,52.7)	<b>28.2*</b> (2.6,53.9)	<b>41.4*</b> (10.9,72.0)	-8.9 (-35.0,17.2)	-0.004 (-21.2,21.2)	11.6 (-9.0,32.2)	25.0 (-2.7,52.6)	30.1 (-8.0,68.1)

\*P value &lt;0.05

**Table S6.** Factors associated with VDBP levels in post-menopausal women.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>h</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>h</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	-0.6 (-1.2,0.1)	<b>-0.9*</b> <b>(-1.6,-0.3)</b>	<b>-1.0*</b> <b>(-1.6,-0.3)</b>	<b>-1.2*</b> <b>(-1.9,-0.6)</b>	<b>-1.2*</b> <b>(-2.4,-0.1)</b>	-0.7 (-1.5,0.2)	<b>-0.9*</b> <b>(-1.6,-0.1)</b>	<b>-1.2*</b> <b>(-1.8,-0.6)</b>	<b>-1.4*</b> <b>(-2.2,-0.6)</b>	<b>-1.7*</b> <b>(-2.8,-0.7)</b>
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	3.1 (-9.8,16.1)	-11.2 (-26.2,3.8)	-9.9 (-22.4,2.7)	-0.7 (-14.9,13.6)	-2.7 (-24.2,18.8)	2.3 (-14.4,19.0)	-7.9 (-23.1,7.4)	<b>-18.3*</b> <b>(-30.8,-5.8)</b>	-8.9 (-25.0,7.2)	-11.1 (-31.8,9.6)
Smoking status										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Current	-23.6 (-46.1,1.9)	-15.2 (-42.7,12.3)	-16.8 (-39.5,6.0)	-4.3 (-29.9,21.3)	-12.5 (-53.5,28.5)	-21.3 (-50.3,7.6)	-4.0 (-20.4,12.5)	<b>-26.6*</b> <b>(-48.2,-4.9)</b>	-22.8 (-50.6,5.0)	-9.2 (-45.1,26.6)
Past	8.9 (-6.3,24.1)	7.4 (-9.0,23.9)	1.9 (-11.6,15.5)	1.8 (-13.4,17.1)	-2.1 (-26.6,22.4)	7.4 (-10.1,24.9)	5.1 (-12.9,23.2)	5.6 (-7.5,18.7)	2.5 (-14.3,19.3)	6.2 (-15.5,27.9)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-3.4 (-19.4,12.6)	-11.6 (-27.7,4.4)	2.3 (-12.4,17.0)	7.8 (-8.6,24.1)	9.6 (-13.5,32.8)	-15.0 (-33.0,3.0)	-4.0 (-20.4,12.5)	7.0 (-6.5,20.5)	14.6 (-2.7,32.0)	12.4 (-10.0,34.7)
Obesity	10.3 (-6.9,27.6)	6.7 (-7.6,27.0)	9.3 (-6.6,25.1)	6.8 (-10.9,24.4)	9.6 (-15.4,34.5)	-0.2 (-20.0,19.5)	5.1 (12.9,23.2)	8.8 (-6.0,23.6)	17.9 (-1.1,36.9)	7.0 (-17.5,31.4)
Total 25-hydroxyvitamin D (ng/mL) <sup>a</sup>	0.9 (-0.1,1.9)	0.8 (-0.2,1.8)	0.6 (-0.3,1.5)	0.2 (-0.8,1.2)	-0.3 (-1.7,1.1)	0.6 (-0.6,1.7)	0.5 (-0.6,1.5)	0.6 (-0.3,1.4)	0.3 (-0.8,1.4)	-1.0 (-2.4,0.4)
Vitamin D intake (UI/day) <sup>a</sup>	0.02 (-0.02,0.06)	-0.01 (-0.05,0.03)	-0.003 (-0.04,0.03)	0.001 (-0.04,0.04)	-0.01 (-0.07,0.05)	0.04 (-0.007,0.09)	0.008 (-0.03,0.05)	0.006 (-0.03,0.04)	0.0002 (-0.04,0.05)	0.02 (-0.04,0.08)
Alcohol(g/day) <sup>a</sup>	0.007 (-1.4,1.4)	-0.44 (-2.0,1.1)	-0.34 (-1.7,1.0)	-0.69 (-2.1,0.7)	-1.5 (-3.6,0.5)	-0.9 (-2.6,0.7)	-0.07 (-1.6,1.4)	-0.1 (-1.4,1.1)	-0.7 (-2.3,0.9)	-1.7 (-3.7,0.4)
rs4588										
CC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
CA+AA	-1.6 (-14.0,10.8)	<b>-18.3*</b> <b>(-28.7,-7.8)</b>	<b>-21.2*</b> <b>(-31.1,-11.3)</b>	<b>-15.1*</b> <b>(-26.2,-4.1)</b>	-16.2 (-32.7,0.31)	-11.0 (-25.5,3.6)	<b>-15.7*</b> <b>(-29.0,-2.4)</b>	<b>-20.3*</b> <b>(-31.2,-9.4)</b>	-13.4 (-27.5,0.6)	-15.9 (-22.9,2.2)
rs7041										
TT	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
TG	1.4 (-11.8,14.7)	9.7 (-6.4,25.8)	8.6 (-4.6,21.9)	4.0 (-10.8,18.7)	-0.7 (-23.6,22.1)	-4.1 (-21.9,13.7)	2.5 (-13.7,18.9)	3.2 (-10.1,16.6)	-3.9 (-21.1,13.2)	-4.7 (-26.8,17.3)
GG	-2.6 (-17.9,12.6)	15.9 (-2.6,34.4)	<b>17.0*</b> <b>(1.8,32.2)</b>	12.6 (-4.3,29.6)	16.4 (-9.9,42.7)	10.1 (-32.2,12.0)	2.9 (-17.3,23.0)	0.4 (-16.1,19.7)	0.7 (-20.6,21.9)	15.7 (-11.7,43.1)

\*P value &lt;0.05

**Table S7.** Factors associated with VDBP levels in normal VitD levels.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.6*</b> (-1.0,-0.3)	<b>-0.5*</b> (-0.8,-0.2)	<b>-0.4*</b> (-0.7,0.1)	-0.2 (-0.5,0.2)	-0.5 (-1.1,0.1)	-0.4 (-0.8,0.1)	<b>-0.4*</b> (-0.8,-0.02)	<b>-0.6*</b> (-1.0,0.2)	<b>-0.3</b> (-0.8,0.1)	-0.5 (-1.1,0.1)
Sex										
Men	Ref. 2.4	Ref. <b>9.6*</b>	Ref. <b>12.6*</b>	Ref. <b>18.1*</b>	Ref. 17.3	Ref. <b>18.5*</b>	Ref. <b>-0.4*</b>	Ref. <b>-0.6*</b>	Ref. 11.6	Ref. 15.4
Women	(-8.5,13.2)	<b>(0.05,19.1)</b>	<b>(2.3,23.0)</b>	<b>(8.5,27.7)</b>	(-0.9,35.4)	<b>(3.3,33.7)</b>	<b>(-0.8,-0.02)</b>	<b>(-1.0,0.2)</b>	(-3.9,27.0)	(-3.0,33.9)
Menopause	<b>-15.3*</b> (-25.1,-5.5)	1.3 (-7.8,10.4)	4.9 (-5.0,14.9)	5.7 (-4.4,15.7)	-1.9 (-21.3,17.5)	<b>-22.6*</b> (-39.6,-5.6)	10.1 (-2.6,22.8)	<b>12.9*</b> (0.5,25.3)	7.3 (-10.0,24.6)	-0.09 (-20.7,20.6)
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	-0.9 (-11.8,10.1)	-4.1 (-13.3,5.0)	-8.5 (-18.3,1.2)	-2.9 (13.2,7.4)	-2.2 (-22.6,18.3)	-1.6 (-13.1,9.9)	0.2 (-13.4,5.8)	-8.5 (-17.8,0.9)	-0.7 (-12.4,11.0)	-7.6 (-21.5,6.3)
Smoking status										
Normal	Ref. 3.5	Ref. 2.4	Ref. -11.4	Ref. -1.4	Ref. -8.5	Ref. -2.7	Ref. -3.0	Ref. -5.1	Ref. 0.5	Ref. -5.1
Current	(-13.3,20.4)	(-11.2,16.0)	(-25.7,2.8)	(-17.2,14.4)	(-38.4,21.3)	(-19.6,14.2)	(-17.2,11.1)	(-18.9,8.6)	(-16.7,17.7)	(-25.6,15.4)
Past	-2.6 (-15.2,10.0)	2.0 (-8.1,12.1)	-5.1 (-15.7,5.5)	2.1 (-9.7,13.8)	-2.7 (-24.9,19.5)	0.02 (-12.4,12.4)	-0.05 (-10.4,10.3)	1.8 (-8.4,11.9)	3.2 (-9.4,15.8)	-0.6 (-15.6,14.5)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-6.9 (-17.3,3.8)	-6.1 (-16.1,3.9)	-9.9 (-20.5,0.7)	-6.1 (-17.7,5.6)	-9.1 (-29.0,10.7)	2.6 (-9.8,14.9)	-5.1 (-15.5,5.2)	-1.1 (-11.1,9.0)	-5.1 (-17.6,7.5)	-7.4 (-22.4,7.5)
Obesity	-6.1 (-18.8,6.7)	-0.1 (-12.0,11.8)	-1.3 (-13.9,11.3)	-2.6 (-16.4,11.2)	-7.6 (-31.2,16.0)	-4.2 (-19.0,10.7)	-1.6 (-14.0,10.8)	1.8 (-10.2,13.9)	-3.5 (-18.6,11.5)	-8.1 (-26.1,9.9)
Total 25-hydroxvitamin D (ng/mL) <sup>a</sup>	0.03 (-1.0,1.01)	0.34 (-0.49,1.17)	0.28 (-0.62,1.18)	0.05 (-0.92,1.01)	-1.28 (-2.89,0.33)	-0.09 (-1.16,1.00)	0.27 (-0.62,1.16)	0.20 (-0.66,1.06)	-0.18 (-1.3,0.9)	-1.4 (-2.7,-0.1)*
Vitamin D intake (UI/day) <sup>a</sup>	0.0009 (-0.03,0.03)	0.003 (-0.02,0.03)	0.003 (-0.02,0.03)	0.003 (-0.02,0.03)	0.0002 (-0.05,0.05)	0.006 (-0.02,0.03)	0.003 (-0.02,0.03)	0.009 (-0.01,0.03)	0.005 (-0.02,0.03)	-0.005 (-0.04,0.03)
Alcohol(g/day) <sup>a</sup>	-0.02 (-0.3,0.3)	0.01 (-0.2,0.2)	-0.05 (-0.3,0.2)	-0.1 (-0.4,0.1)	-0.2 (-0.7,0.3)	0.05 (-0.22,0.31)	-0.008 (-0.23,0.21)	-0.07 (-0.28,0.15)	-0.10 (-0.37,0.16)	-0.10 (-0.42,0.22)
rs4588										
CC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
CA+AA	-7.7 (-18.2,2.8)	<b>-14.2*</b> (-22.7,-5.7)	<b>-20.3*</b> (-28.5,-12.0)	<b>-14.8*</b> (-24.4,-5.2)	-14.5 (-29.8,0.8)	-10.7 (-21.9,0.5)	<b>-15.7*</b> (-25.0,-6.3)	<b>-19.3*</b> (-28.4,-10.2)	<b>-12.1*</b> (-23.4,-0.7)	-12.0 (-9.6,30.2)
rs7041										
TT	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
TG	5.8 (-6.6,18.2)	<b>14.7*</b> (4.1,25.3)	<b>17.9*</b> (6.6,29.2)	<b>15.0*</b> (2.6,27.4)	10.4 (-11.3,32.0)	5.4 (-8.0,18.8)	<b>12.2*</b> (1.0,23.4)	<b>11.9*</b> (1.0,22.8)	5.9 (-7.8,19.5)	2.4 (-13.8,18.7)
GG	1.7 (-12.7,16.0)	8.5 (-3.7,20.8)	<b>21.1*</b> (8.0,34.1)	<b>16.0*</b> (1.7,30.4)	23.0 (-2.0,48.1)	-5.3 (-21.7,11.1)	-1.1 (-14.8,12.7)	10.6 (-2.7,24.0)	7.6 (-9.1,24.3)	10.3 (-9.6,30.2)

\*P value &lt;0.05

**Table S8.** Factors associated with VDBP levels in deficiency VitD levels.

Variable	Univariable model					Multivariable model				
	Coefficient (95% CI)					Coefficient (95% CI)				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
Age(years)	<b>-0.7*</b> (-1.1,-0.4)	<b>-0.6*</b> (-0.9,-0.3)	<b>-0.3</b> (-0.6,0.1)	-0.02 (-0.5,0.5)	-0.2 (-0.8,0.3)	<b>-0.9*</b> (-1.5,-0.3)	<b>-0.8*</b> (-1.2,-0.3)	-0.2 (-0.6,0.3)	-0.1 (-0.8,0.5)	0.05 (-0.7,0.8)
Sex										
Men	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Women	-1.6 (-15.6,12.4)	2.1 (-10.4,14.5)	10.6 (-1.4,22.5)	9.5 (-7.4,26.3)	19.0 (-4.9,42.9)	8.0 (-11.8,27.8)	1.2 (-13.9,16.3)	12.8 (-2.6,28.3)	16.2 (-5.9,38.3)	<b>28.3*</b> ( <b>3.0,53.7</b> )
Menopause	-7.8 (-21.4,5.8)	-6.7 (-17.7,4.3)	-0.6 (-11.5,10.3)	-5.9 (-20.9,9.1)	-13.8 (-31.1,3.4)	-1.2 (-23.3,21.0)	8.9 (-7.9,25.8)	-6.0 (-23.3,11.3)	-12.9 (-37.6,11.9)	-14.1 (-42.5,14.3)
Leisure time physical activity										
Inactive (<30 min/day)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Active (≥30 min/day)	1.8 (-11.8,15.5)	-3.4 (-15.6,8.8)	-0.9 (-12.4,10.6)	0.4 (-16.4,17.2)	-10.2 (-31.5,11.0)	1.7 (-14.2,17.5)	-0.9 (-12.9,11.2)	-4.0 (-16.4,8.4)	-0.5 (-18.2,17.2)	-0.6 (-20.9,19.8)
Smoking status										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Current	-3.7 (-24.9,17.6)	-4.5 (-22.8,13.7)	-13.8 (-31.3,3.8)	-2.4 (-27.6,22.8)	-16.2 (-50.4,18.0)	-9.5 (-33.9,15.0)	-9.4 (-28.0,9.2)	-11.8 (-30.9,7.3)	-1.1 (-22.4,20.1)	-7.2 (-38.5,24.2)
Past	-5.7 (-20.8,9.3)	-2.0 (-15.0,10.9)	4.1 (-8.4,16.5)	10.5 (-7.3,28.4)	1.1 (-23.1,25.4)	-3.6 (-20.8,13.5)	0.5 (-12.6,13.6)	5.5 (-7.8,19.0)	-1.8 (-20.8,17.2)	20.0 (-2.0,42.1)
BMI (kg/m <sup>2</sup> )										
Normal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-1.1 (-17.0,14.7)	-11.0 (-24.9,2.8)	-4.7 (-18.5,9.0)	-9.9 (-28.5,8.7)	-5.4 (-34.7,23.9)	-5.8 (-22.9,11.2)	-6.2 (-19.2,6.8)	-0.5 (-13.8,12.8)	-1.7 (-4.4,1.0)	-9.6 (-31.4,12.2)
Obesity	1.2 (-16.5,19.0)	-11.9 (-24.3,0.5)	-3.8 (-16.0,8.5)	0.3 (-16.3,16.9)	-9.6 (-35.8,16.6)	-13.0 (-32.0,6.0)	-12.1 (-26.6,2.4)	-8.6 (-23.4,6.3)	-1.1 (-22.4,20.1)	-4.4 (-28.8,20.0)
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	1.1 (-1.0,3.3)	0.01 (-1.8,1.8)	-1.8 (-3.6,-0.05)	-1.8 (-4.3,0.8)	-2.8 (-6.0,0.4)	0.7 (-1.7,3.1)	-0.003 (-1.8,1.8)	-1.8 (-3.6,0.1)	-1.7 (-4.4,1.0)	-2.0 (-5.1,1.0)
Vitamin D intake (UI/day) <sup>a</sup>	-0.04 (-0.09,0.0001)	-0.02 (-0.05,0.02)	-0.02 (-0.05,0.02)	-0.02 (-0.07,0.03)	-0.003 (-0.08,0.07)	-0.002 (-0.05,0.05)	-0.005 (-0.04,0.03)	-0.02 (-0.06,0.02)	-0.04 (-0.1,0.01)	0.03 (-0.04,0.09)
Alcohol(g/day) <sup>a</sup>	0.2 (-0.4,0.9)	0.09 (-0.5,0.7)	<b>0.7*</b> ( <b>0.2,1.3</b> )	0.4 (-0.4,1.2)	0.2 (-0.9,1.2)	0.4 (-0.4,1.2)	0.4 (-0.2,1.0)	<b>0.7*</b> ( <b>0.1,1.3</b> )	0.4 (-0.4,1.3)	0.2 (-0.8,1.2)
rs4588										
CC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
CA+AA	-9.1 (-21.6,3.4)	<b>-16.9*</b> ( <b>-26.5,-7.2</b> )	<b>-20.4*</b> ( <b>-30.1,-10.7</b> )	<b>-21.0*</b> ( <b>-32.5,-9.5</b> )	<b>-20.1*</b> ( <b>-36.5,-3.6</b> )	-10.0 (-24.2,4.2)	<b>-15.1*</b> ( <b>-25.9,-4.3</b> )	<b>-15.3*</b> ( <b>-26.4,-4.2</b> )	<b>-16.8*</b> ( <b>-32.6,-1.0</b> )	-11.7 (-29.9,6.5)
rs7041										
TT	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
TG	2.6 (-16.7,11.5)	3.1 (-10.4,16.6)	<b>12.2*</b> ( <b>0.1,24.2</b> )	<b>18.6*</b> ( <b>1.3,36.0</b> )	<b>23.3*</b> ( <b>3.5,43.2</b> )	-6.8 (-23.8,10.2)	-0.008 (-12.9,12.9)	4.4 (-8.9,17.6)	8.5 (-10.4,27.5)	15.8 (-6.0,37.6)
GG	8.4 (-9.1,25.9)	15.1 (-1.6,31.9)	<b>24.4*</b> ( <b>9.4,39.4</b> )	<b>28.9*</b> ( <b>7.4,50.5</b> )	<b>47.8*</b> ( <b>23.1,72.5</b> )	-5.6 (-28.8,17.6)	6.7 (-11.0,24.4)	10.3 (-7.9,28.4)	17.4 (-8.4,43.3)	<b>39.3*</b> ( <b>9.6,69.5</b> )



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\*P value <0.05

**Table S9.** Associations between *GC* gene variants and hip BMD in all participants.

	n	Categorical hip BMD				Continuous hip BMD			
		Crude model OR (95% CI)	<i>P</i> value	Adjusted model OR (95% CI)	<i>P</i> value	Crude model $\beta$ (95% CI)	<i>P</i> value	Adjusted model $\beta$ (95% CI)	<i>P</i> value
rs4588									
CC	1,122	Ref.		Ref.		Ref.		Ref.	
CA+AA	699	1.16(0.93,1.44)	0.178	1.14(0.88,1.46)	0.326	-0.02(-0.03,-0.001)	0.036	-0.01(-0.02,0.002)	0.138
rs7041									
TT	499	Ref.		Ref.		Ref.		Ref.	
TG	904	0.88(0.67,1.13)	0.321	0.87(0.65,1.16)	0.354	0.005(-0.01,0.02)	0.529	-0.0001(-0.01,0.01)	0.991
GG	419	0.79(0.58,1.07)	0.123	0.75(0.53,1.07)	0.113	0.01(-0.009,0.03)	0.273	0.01(-0.01,0.03)	0.196
Haplotype									
1S/1S	404	Ref.		Ref.		Ref.		Ref.	
1F/1S	537	1.05(0.77,1.42)	0.770	1.05(0.74,1.49)	0.796	0.0005(-0.02,0.02)	0.962	-0.005(-0.02,0.01)	0.529
1F/1F	181	1.04(0.69,1.58)	0.845	1.17(0.73,1.87)	0.521	-0.01(-0.04,0.02)	0.407	-0.02(-0.04,0.004)	0.119
1S/2	365	1.13(0.81,1.57)	0.479	1.17(0.80,1.71)	0.429	-0.019(-0.04,0.002)	0.081	<b>-0.02(-0.04,-0.002)</b>	<b>0.025</b>
1F/2	267	1.14(0.80,1.64)	0.467	1.14(0.75,4.82)	0.534	-0.008(-0.03,0.02)	0.503	-0.006(-0.03,0.01)	0.505
2/2	51	<b>2.75(1.51,5.00)</b>	<b>0.001</b>	<b>2.40(1.19,4.80)</b>	<b>0.014</b>	-0.04(-0.09,0.002)	0.059	-0.01(-0.05,0.02)	0.474

Model adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active  $\geq 150$  min/week), smoking (never, current, past), vitamin D intake. Traditional nomenclature referring to the protein phenotypes: (a) GC1F (rs7041-T/rs4588-C); (b) GC1S (rs7041-G/rs4588-C) and (c) GC2 (rs7041-T/rs4588-A).

**Table S10.** Associations between *GC* gene variants and hip BMD by sex.

All women										All men							
Categorical hip BMD										Continuous hip BMD							
Crude model					Adjusted model					Crude model				Adjusted model			
n	OR (95% CI)	P value	OR (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	n	OR (95% CI)	P value	OR (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
rs4588																	
CC	773	Ref.		Ref.		Ref.			349	Ref.		Ref.		Ref.		Ref.	
CA+AA	495	1.10 (0.9,1.4)	0.426	1.08 (0.80,1.45)	0.629	-0.02 (-0.03,0.0001)	0.051	-0.009 (-0.02,0.004)	0.183	1.30 (0.83,2.04)	0.248	1.31 (0.79,2.17)	0.295	-0.01 (-0.03,0.02)	0.601	-0.01 (-0.03,0.02)	0.531
rs7041																	
TT	355	Ref.		Ref.		Ref.			144	Ref.		Ref.		Ref.		Ref.	
TG	615	0.84 (0.63,1.12)	0.283	0.81 (0.58,1.14)	0.226	0.01 (-0.006,0.03)	0.186	0.01 (-0.01,0.03)	0.192	1.13 (0.65,1.96)	0.657	1.32 (0.72,2.43)	0.367	-0.02 (-0.05,0.005)	0.099	-0.03 (-0.05,-0.01)	0.039
GG	299	<b>0.66</b> <b>(0.47,0.94)</b>	<b>0.021</b>	<b>0.62</b> <b>(0.41,0.94)</b>	<b>0.025</b>	<b>0.03</b> <b>(0.005,0.05)</b>	<b>0.018</b>	<b>0.02</b> <b>(0.003,0.04)</b>	<b>0.021</b>	1.39 (0.73,2.62)	0.315	1.40 (0.69,2.83)	0.346	-0.03 (-0.06,0.008)	0.128	-0.02 (-0.05,0.01)	0.223
Haplotype																	
1S/1S	286	Ref.		Ref.		Ref.			118	Ref.		Ref.		Ref.		Ref.	
1F/1S	353	1.26 (0.88,1.80)	0.202	1.23 (0.81,1.88)	0.333	-0.01 (-0.03,0.01)	0.285	-0.01 (-0.03,0.01)	0.443	0.67 (0.37,1.24)	0.201	0.76 (0.39,1.51)	0.439	0.01 (-0.02,0.05)	0.468	0.001 (-0.03,0.03)	0.933
1F/1F	134	1.29 (0.81,2.05)	0.277	1.47 (0.85,2.52)	0.167	-0.03 (-0.05,0.005)	0.099	<b>-0.03</b> <b>(-0.05,-0.01)</b>	<b>0.015</b>	0.36 (0.12,1.11)	0.077	0.40 (0.12,1.31)	0.129	0.04 (-0.01,0.09)	0.123	0.02 (-0.02,0.07)	0.298
1S/2	260	1.16 (0.79,1.70)	0.454	1.17 (0.74,1.86)	0.493	-0.02 (-0.05,0.003)	0.079	-0.02 (-0.04,0.002)	0.073	1.04 (0.54,1.99)	0.910	1.28 (0.61,2.68)	0.509	-0.01 (-0.05,0.03)	0.540	-0.02 (-0.06,0.01)	0.172
1F/2	185	1.33 (0.88,2.02)	0.178	1.37 (0.84,2.24)	0.207	-0.03 (-0.05,0.001)	0.060	-0.02 (-0.04,0.004)	0.108	0.74 (0.35,1.55)	0.423	0.67 (0.29,1.52)	0.335	0.03 (-0.01,0.07)	0.184	0.02 (-0.01,0.06)	0.235
2/2	36	<b>3.14</b> <b>(1.55,6.38)</b>	<b>0.001</b>	<b>2.35</b> <b>(1.01,5.46)</b>	<b>0.047</b>	<b>-0.06</b> <b>(-0.11,-0.01)</b>	<b>0.020</b>	-0.01 (-0.05,0.03)	0.515	1.96 (0.61,6.27)	0.257	2.31 (0.63,8.40)	0.205	-0.004 (-0.08,0.07)	0.909	-0.005 (-0.07,0.07)	0.895

Model adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active  $\geq 150$  min/week), smoking (never, current, past), vitamin D intake. Traditional nomenclature referring to the protein phenotypes: (a) GC1F (rs7041-T/rs4588-C); (b) GC1S (rs7041-G/rs4588-C) and (c) GC2 (rs7041-T/rs4588-A).

**Table S11.** Associations between GC gene variants and low hip BMD by status menopausal.

Premenopausal women										Postmenopausal women								
Categorical hip BMD					Continuous hip BMD					Categorical hip BMD				Continuous hip BMD				
	n	Crude model		Adjusted model		Crude model		Adjusted model			Crude model		Adjusted model		Crude model		Adjusted model	
		OR (95% CI)	P value	OR (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	n	OR (95% CI)	P value	OR (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
rs4588																		
CC	305	Ref.		Ref.		Ref.		Ref.		468	Ref.		Ref.		Ref.		Ref.	
CA+AA	200	1.62 (0.97,2.73)	0.066	1.44 (0.80,2.62)	0.228	-0.03 (-0.05,-0.004)	0.022	-0.02 (-0.04,0.01)	0.149	295	1.00 (0.74,1.35)	0.996	1.03 (0.73,1.47)	0.859	-0.007 (-0.03,0.01)	0.489	-0.005 (-0.02,0.01)	0.596
rs7041																		
TT	139	Ref.		Ref.		Ref.		Ref.		216	Ref.		Ref.		Ref.		Ref.	
TG	260	0.62 (0.35,1.09)	0.099	0.56 (0.29,1.07)	0.086	0.02 (-0.01,0.05)	0.142	0.02 (-0.007,0.04)	0.176	355	0.98 (0.69,1.38)	0.895	0.87 (0.62,1.21)	0.410	0.001 (-0.02,0.02)	0.935	0.005 (-0.02,0.02)	0.639
GG	106	0.48 (0.22,1.04)	0.062	0.51 (0.51,1.18)	0.116	<b>0.04</b> <b>(0.01,0.07)</b>	<b>0.008</b>	<b>0.03</b> <b>(-0.01,0.06)</b>	<b>0.017</b>	193	0.66 (0.44,1.01)	0.054	<b>0.65</b> <b>(0.43,0.98)</b>	<b>0.040</b>	0.02 (-0.006,0.05)	0.128	0.01 (-0.009,0.04)	0.246
Haplotype																		
1S/1S	104	Ref.		Ref.		Ref.		Ref.		182	Ref.		Ref.		Ref.		Ref.	
1F/1S	148	1.06 (0.46,2.46)	0.892	0.87 (0.35,2.19)	0.775	-0.01 (-0.05,0.02)	0.390	-0.01 (-0.04,0.02)	0.394	205	1.51 (0.99,2.28)	0.054	0.91 (0.37,2.25)	0.866	-0.02 (-0.05,0.01)	0.117	-0.01 (-0.03,0.02)	0.580
1F/1F	53	1.67 (0.62,4.52)	0.312	2.03 (0.69,5.93)	0.197	<b>-0.05</b> <b>(-0.08,-0.003)</b>	<b>0.037</b>	<b>-0.04</b> <b>(-0.08,-0.006)</b>	<b>0.021</b>	81	1.29 (0.75,2.23)	0.356	1.75 (0.61,5.03)	0.233	-0.02 (-0.06,0.02)	0.304	-0.02 (-0.05,0.01)	0.194
1S/2	112	1.57 (0.68,3.63)	0.295	1.33 (0.54,3.30)	0.537	<b>-0.04</b> <b>(-0.07,-0.005)</b>	<b>0.025</b>	-0.03 (-0.06,0.002)	0.071	148	1.20 (0.76,1.89)	0.439	1.54 (0.64,3.72)	0.325	-0.02 (-0.05,0.01)	0.196	-0.01 (-0.04,0.01)	0.332
1F/2	74	1.64 (0.66,4.09)	0.288	1.34 (0.49,3.68)	0.570	<b>-0.04</b> <b>(-0.08,-0.0001)</b>	<b>0.049</b>	-0.03 (-0.06,0.006)	0.106	111	1.37 (0.84,2.24)	0.210	1.54 (0.57,4.14)	0.475	-0.02 (-0.05,0.01)	0.232	-0.01 (-0.04,0.01)	0.367
2/2	12	<b>9.40</b> <b>(2.54,34.70)</b>	<b>0.001</b>	<b>6.88</b> <b>(1.51,31.4)</b>	<b>0.013</b>	<b>-0.08</b> <b>(-0.16,-0.004)</b>	<b>0.040</b>	-0.04 (-0.10,0.03)	0.310	24	2.08 (0.88,4.92)	0.093	<b>8.46</b> <b>(1.97,36.30)</b>	<b>0.004</b>	-0.04 (-0.10,0.02)	0.211	0.0004 (-0.05,0.05)	0.986

Model adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active  $\geq 150$  min/week), smoking (never, current, past), vitamin D intake. Traditional nomenclature referring to the protein phenotypes: (a) GC1F (rs7041-T/rs4588-C); (b) GC1S (rs7041-G/rs4588-C) and (c) GC2 (rs7041-T/rs4588-A).

**Table S12.** Spearman correlation between VDBP levels, different forms of 25(OH)D and BMD by menopausal status.

	Premenopausal Women						Postmenopausal women					
	Hip BMD g/cm <sup>2</sup>		Femoral neck g/cm <sup>2</sup>		Lumbar spine g/cm <sup>2</sup>		Hip BMD g/cm <sup>2</sup>		Femoral neck g/cm <sup>2</sup>		Lumbar spine g/cm <sup>2</sup>	
	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value
VDBP levels (μmol/l)	-0.046	0.300	-0.003	0.944	-0.043	0.333	0.158	<0.001	0.140	<0.001	0.026	0.470
Total 25-hydroxivitamin D (ng/mL)	-0.026	0.264	-0.031	0.483	0.042	0.346	0.083	0.021	0.119	0.0009	0.080	0.025
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	-0.007	0.874	-0.012	0.777	0.053	0.211	-0.007	0.861	0.025	0.506	0.044	0.240
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	-0.016	0.712	-0.007	0.871	0.060	0.158	0.009	0.811	0.047	0.203	0.060	0.107
Free 25-hydroxivitamin D-SNP adjusted (pg/mL)	0.029	0.513	0.036	0.427	0.057	0.203	-0.003	0.942	0.010	0.795	0.027	0.464
Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL)	0.002	0.701	0.035	0.431	0.059	0.186	0.008	0.838	0.025	0.423	0.039	0.286

**Table S13.** Spearman correlation between VDBP levels, different forms of 25(OH)D and BMD by sex.

	All Women						All men					
	Hip BMD g/cm <sup>2</sup>		Femoral neck g/cm <sup>2</sup>		Lumbar spine g/cm <sup>2</sup>		Hip BMD g/cm <sup>2</sup>		Femoral neck g/cm <sup>2</sup>		Lumbar spine g/cm <sup>2</sup>	
	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value
VDBP levels (μmol/l)	0.089	0.002	0.096	0.005	0.032	0.248	-0.057	0.179	-0.074	0.079	-0.061	0.151
Total 25-hydroxivitamin D (ng/mL)	0.015	0.588	0.039	0.161	0.040	0.153	0.047	0.269	0.059	0.159	0.053	0.208
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	-0.021	0.451	-0.011	0.701	0.016	0.573	-0.078	0.064	-0.100	0.019	-0.088	0.036
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	-0.003	0.909	-0.021	0.450	0.020	0.468	-0.063	0.136	-0.055	0.191	-0.095	0.024
Free 25-hydroxivitamin D-SNP adjusted (pg/mL)	-0.007	0.814	-0.001	0.964	0.009	0.752	-0.033	0.445	-0.054	0.206	-0.069	0.104
Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL)	-0.007	0.811	0.005	0.851	0.015	0.605	-0.017	0.684	-0.027	0.535	-0.078	0.067

**Table S14.** Descriptive statistics by sex and BMD status.

Characteristics	Premenopausal women			Postmenopausal women			Men		
	Normal hip BMD	Low hip BMD	<i>P</i> value	Normal hip BMD	Low hip BMD	<i>P</i> value	Normal hip BMD	Low hip BMD	<i>P</i> value
	n=444	n=69		n=484	n=292		n=463	n=100	
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	20.4 (19.7-21.1)	19.6 (17.9-21.2)	0.103	21.4 (20.8-22.0)	20.5 (19.7-21.0)	0.982	22.1 (20.6-23.6)	22.1 (20.6-23.6)	0.205
Vitamin D-binding protein (μmol/l) <sup>a</sup>	278.5 (271-285.6)	285.3 (267.7-303.0)	0.601	282.4 (274.3-289.6)	258.1 (249.0-267.1)	0.009	264.5 (258.1-270.9)	263.8 (250.0-277.7)	0.757
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	5.6 (5.4-5.8)	5.2 (4.6-5.8)	0.062	5.8 (5.6-6.1)	5.8 (5.5-6.1)	0.743	6.3 (6.1-6.6)	6.1 (5.5-6.6)	0.107
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	2.1 (2.0-2.2)	2.0 (1.7-2.2)	0.066	2.2 (2.1-2.3)	2.2 (2.1-2.3)	0.825	2.4 (2.3-2.5)	2.3 (2.1-2.5)	0.060
Free 25-hydroxivitamin D-SNP adjusted (pg/mL) <sup>a</sup>	6.4 (6.0-6.7)	5.7 (4.8-6.5)	0.159	6.5 (6.2-6.8)	6.7 (6.3-7.2)	0.144	7.3 (6.9-7.6)	6.7 (6.0-7.5)	0.052
Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL) <sup>a</sup>	2.4 (2.2-2.5)	2.1 (1.7-2.4)	0.121	2.5 (2.4-2.6)	2.5 (2.3-2.6)	0.690	2.8 (2.7-2.9)	2.6 (2.3-2.9)	0.037
Characteristics	Normal femoral neck BMD	Low femoral neck BMD	<i>P</i> value	Normal femoral neck BMD	Low femoral neck BMD	<i>P</i> value	Normal femoral neck BMD	Low femoral neck BMD	<i>P</i> value
	n=411	n=102		n=331	n=442		n=408	n=151	
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	20.4 (19.7-21.0)	19.6 (18.4-21.0)	0.025	21.8 (21.1-22.5)	20.6 (20.0-21.2)	0.718	21.9 (21.2-22.7)	22.5 (21.4-23.7)	0.578
Vitamin D-binding protein (μmol/l) <sup>a</sup>	278.2 (271.0-285.4)	283.7 (269.9-297.5)	0.528	283.6 (275.1-292.1)	265.2 (258.0-272.4)	0.075	265.2 (258.1-272.3)	262.8 (251.1-274.4)	0.852
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	5.6 (5.3-5.8)	5.3 (4.8-5.8)	0.133	5.9 (5.7-6.2)	5.8 (5.5-6.0)	0.877	6.3 (6.0-6.6)	6.4 (5.9-6.8)	0.371
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	2.1 (1.0-2.2)	2.0 (1.8-2.2)	0.154	2.2 (2.1-2.3)	2.2 (2.1-2.3)	0.967	2.4 (2.3-2.5)	2.4 (2.2-2.6)	0.571
Free 25-hydroxivitamin D-SNP adjusted (pg/mL) <sup>a</sup>	6.4 (6.0-6.7)	5.7 (4.9-6.4)	0.143	6.6 (6.2-7.0)	6.5 (6.2-6.9)	0.975	7.3 (6.9-7.6)	7.2 (6.7-7.8)	0.273
Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL) <sup>a</sup>	2.4 (2.2-2.5)	2.1 (1.9-2.4)	0.181	2.6 (2.4-2.7)	2.4 (2.3-2.6)	0.587	2.8 (2.6-2.9)	2.8 (2.6-3.0)	0.768
Characteristics	Normal lumbar spine BMD	Low lumbar spine BMD	<i>P</i> value	Normal lumbar spine BMD	Low lumbar spine BMD	<i>P</i> value	Normal lumbar spine BMD	Low lumbar spine BMD	<i>P</i> value
	n=373	n=140		n=227	n=546		n=318	n=245	
Total 25-hydroxivitamin D (ng/mL) <sup>a</sup>	20.8 (20.0-21.6)	19.5 (18.3-20.8)	0.037	21.3 (20.5-22.2)	21.0 (20.5-21.6)	0.786	21.3 (20.5-22.2)	22.6 (21.7-23.6)	0.157
Vitamin D-binding protein (μmol/l) <sup>a</sup>	278.6 (270.9-286.3)	281.3 (269.0-293.6)	0.615	272.8 (261.8-283.8)	271.7 (264.9-278.6)	0.625	267.0 (259.4-274.6)	260.5 (251.8-269.2)	0.142
Free 25-hydroxivitamin D (pg/mL) <sup>a</sup>	5.6 (5.3-5.9)	5.3 (4.9-5.7)	0.145	5.9 (5.6-6.2)	5.8 (5.6-6.0)	0.780	5.9 (5.6-6.2)	6.5 (6.2-6.9)	0.021
Bioavailable 25-hydroxivitamin D (ng/mL) <sup>a</sup>	2.1 (2.0-2.2)	2.0 (1.8-2.2)	0.125	2.2 (2.1-2.4)	2.2 (2.1-2.3)	0.687	2.3 (2.2-2.4)	2.5 (2.4-2.7)	0.021
Free 25-hydroxivitamin D-SNP adjusted (pg/mL) <sup>a</sup>	6.4 (6.0-6.8)	5.9 (5.2-6.5)	0.258	6.6 (6.1-7.1)	6.6 (6.3-6.9)	0.861	7.0 (6.6-7.4)	7.5 (7.0-8.0)	0.267

Bioavailable 25-hydroxivitamin D-SNP adjusted (ng/mL) <sup>a</sup>	2.4 (2.2-2.5)	2.2 (2.0-2.4)	0.283	2.5 (2.3-2.7)	2.5 (2.4-2.6)	0.854	2.7 (2.5-2.9)	2.9 (2.7-3.1)	0.306
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<sup>a</sup> Adjusted median (95% CI). Median adjusted by age groups, BMI (normal, overweight, obesity), leisure time physical activity (active >150 min/week), vitamin D intake (quartiles) and smoking (never, smoking, former smoker). Low BMD was defined as a T-score less than -1 at the femoral neck, lumbar spine and hip, according to WHO criteria.

**Table S15.** Association between VDBP categories and low hip BMD in all participants.

Model	All participants n=1,853 VDBP tertiles					All women n=1,289 VDBP tertiles				
	Low (106.8-246.3) OR (95% CI)	Medium (246.4-299.5) OR (95% CI)	<i>P</i> value	High (299.52-449.7) OR (95% CI)	<i>P</i> value	Low (106.8-250.5)	Medium (250.9-304.1)		High (304.2-449.7)	
Crude	Ref.	<b>0.71</b> <b>(0.55,0.92)</b>		<b>0.71</b> <b>(0.55,0.92)</b>		Ref.	<b>0.69</b> <b>(0.52,0.92)</b>		<b>0.53</b> <b>(0.39,0.72)</b>	
Adjusted <sup>1</sup>	Ref.	0.84 (0.63,1.13)	0.255	0.78 (0.58,1.01)	0.103	Ref.	0.79 (0.56,1.11)	0.181	<b>0.67</b> <b>(0.46,0.95)</b>	<b>0.026</b>
Adjusted <sup>2</sup>	Ref.	0.86 (0.64,1.16)	0.332	0.80 (0.59,1.08)	0.137	Ref.	0.80 (0.57,1.13)	0.217	<b>0.67</b> <b>(0.47,0.96)</b>	<b>0.029</b>

Model 1 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active >30 min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active >30 min/day), smoking (never, current, past), vitamin D intake and 25-hydroxivitamin D levels. a Low, medium and high VDBP category levels were defined by tertiles. \*Minimum -maximum value of each category.



**Table S16.** Association between VDBP levels and BMD by menopausal status.

Model	Premenopausal, n=513						Postmenopausal, n=776					
	Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )		Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )	
	$\beta$ (95% CI)	P value	$\beta$ (95% CI)	P value	$\beta$ (95% CI)	P value	$\beta$ (95% CI)	P value	$\beta$ (95% CI)	P value	$\beta$ (95% CI)	P value
Crude	-0.02 (-0.07,0.03)	0.479	0.009 (-0.04,0.06)	0.705	-0.01 (-0.06,0.04)	0.579	<b>0.07</b> <b>(0.03,0.11)</b>	<b>&lt;0.001</b>	<b>0.06</b> <b>(0.03,0.10)</b>	<b>0.001</b>	0.03 (-0.02,0.07)	0.213
Adjusted <sup>1</sup>	-0.009 (-0.05,0.04)	0.699	0.006 (-0.04,0.05)	0.783	-0.02 (-0.07,0.03)	0.468	0.02 (-0.01,0.06)	0.165	0.02 (-0.01,0.05)	0.235	0.01 (-0.03,0.05)	0.650
Adjusted <sup>2</sup>	-0.01 (-0.05,0.04)	0.733	0.009 (-0.03,0.05)	0.694	-0.01 (-0.06,0.04)	0.615	0.02 (-0.01,0.06)	0.186	0.02 (-0.01,0.05)	0.284	0.008 (-0.04,0.05)	0.721

\* VDBP levels were logarithmically transformed to the base 10. Model 1 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active  $\geq 30$  min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active  $\geq 30$  min/day), smoking (never, current, past), vitamin D intake and 25-hydroxyvitamin D levels.

**Table S17.** Association between VDBP levels and BMD by VitD status.

Model	Normal Vitamin D, n=1,077						Deficiency Vitamin D, n=775					
	Hip BMD (g/cm <sup>2</sup> ) β (95% CI)	P value	Femoral neck (g/cm <sup>2</sup> ) β (95% CI)	P value	Spine lumbar (g/cm <sup>2</sup> ) β (95% CI)	P value	Hip BMD (g/cm <sup>2</sup> ) β (95% CI)	P value	Femoral neck (g/cm <sup>2</sup> ) β (95% CI)	P value	Spine lumbar (g/cm <sup>2</sup> ) β (95% CI)	P value
Crude	0.03 (-0.01,0.07)	0.090	<b>0.05</b> <b>(0.01,0.09)</b>	<b>0.008</b>	<b>0.04</b> <b>(0.001,0.09)</b>	<b>0.047</b>	0.04 (-0.003,0.09)	0.069	0.05 (-0.002,0.09)	0.059	0.01 (-0.04,0.06)	0.797
Adjusted <sup>1</sup>	0.02 (-0.01,0.05)	0.281	0.03 (-0.004,0.06)	0.095	0.03 (-0.09,0.07)	0.123	0.03 (-0.002,0.07)	0.068	0.03 (-0.006,0.07)	0.102	0.007 (-0.04,0.05)	0.775
Adjusted <sup>2</sup>	0.02 (-0.02,0.05)	0.302	0.03 (-0.005,0.06)	0.100	0.03 (-0.01,0.07)	0.128	0.04 (-0.001,0.07)	0.063	0.03 (-0.005,0.07)	0.090	0.009 (-0.04,0.05)	0.699

\* VDBP levels were logarithmically transformed to the base 10. Model 1 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day), smoking (never, current, past) and vitamin D intake.

**Table S18.** Association between VitD levels and BMD in all population.

All participants, n=1,853						
Total 25 hydroxivitamin D						
Model	Hip BMD (g/cm <sup>2</sup> )	P value	Femoral neck (g/cm <sup>2</sup> )	P value	Spine lumbar (g/cm <sup>2</sup> )	P value
	β (95% CI)		β (95% CI)		β (95% CI)	
Crude	0.02 (-0.0008,0.05)	0.059	<b>0.03</b> <b>(0.003,0.05)</b>	<b>0.030</b>	0.03 (-0.001,0.05)	0.055
Adjusted <sup>1</sup>	0.0007 (-0.0002,0.002)	0.109	<b>0.02</b> <b>(0.003,0.04)</b>	<b>0.020</b>	0.02 (-0.006,0.04)	0.152
Adjusted <sup>2</sup>	0.02 (-0.002,0.04)	0.073	<b>0.02</b> <b>(0.002,0.04)</b>	<b>0.027</b>	0.02 (-0.007,0.04)	0.178
Free 25 hydroxivitamin D						
Crude	0.007 (-0.009,0.02)	0.404	0.006 (-0.01,0.02)	0.455	0.008 (-0.01,0.03)	0.393
Adjusted <sup>1</sup>	0.002 (-0.01,0.02)	0.717	0.004 (-0.01,0.02)	0.532	0.004 (-0.01,0.02)	0.629
Adjusted <sup>2</sup>	0.002 (-0.01,0.02)	0.711	0.004 (-0.008,0.02)	0.519	0.004 (-0.01,0.02)	0.618
Bioavailable 25 hydroxivitamin D						
Crude	0.01 (-0.01,0.03)	0.347	0.02 (-0.004,0.04)	0.124	0.007 (-0.02,0.03)	0.535
Adjusted <sup>1</sup>	0.005 (-0.01,0.02)	0.522	0.01 (-0.004,0.03)	0.156	0.002 (-0.02,0.02)	0.771
Adjusted <sup>2</sup>	0.005 (-0.01,0.02)	0.507	0.01 (-0.004,0.03)	0.152	0.003 (-0.02,0.02)	0.801

\*Vitamin D levels (total, free and bioavailable 25 hydroxyvitamin D) were logarithmically transformed to the base 10. Model 1 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, sex, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day), smoking (never, current, past) and vitamin D intake.

**Table S19.** Association between VitD levels and BMD by sex.

All women, n=1289							All men, n=564					
Total 25 hydroxivitamin D												
	Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )		Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )	
Model	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
Crude	0.01 (-0.02,0.04)	0.415	0.02 (-0.005,0.05)	0.111	0.02 (-0.01,0.05)	0.217	<b>-0.02</b> <b>(-0.06,0.02)</b>	<b>0.438</b>	<b>-0.02</b> <b>(-0.07,0.02)</b>	<b>0.312</b>	-0.01 (-0.06,0.03)	0.549
Adjusted <sup>1</sup>	0.0004 (-0.001,0.001)	0.421	<b>0.02</b> <b>(0.001,0.04)</b>	<b>0.036</b>	0.02 (-0.002,0.05)	0.070	0.001 (-0.003,0.003)	0.120	0.02 (-0.01,0.06)	0.221	0.009 (-0.04,0.05)	0.695
Adjusted <sup>2</sup>	0.013 (-0.008,0.03)	0.229	<b>0.02</b> <b>(0.0003,0.04)</b>	<b>0.047</b>	0.02 (-0.003,0.05)	0.087	0.02 (-0.01,0.06)	0.202	0.02 (-0.02,0.06)	0.287	0.006 (-0.04,0.05)	0.778
Free 25 hydroxivitamin D												
Crude	-0.005 (-0.02,0.01)	0.594	-0.004 (-0.02,0.01)	0.644	0.003 (-0.02,0.02)	0.764	-0.008 (-0.04,0.02)	0.573	-0.008 (-0.04,0.02)	0.583	-0.02 (-0.05,0.02)	0.324
Adjusted <sup>1</sup>	0.001 (-0.01,0.02)	0.857	0.003 (-0.01,0.02)	0.642	0.01 (-0.005,0.03)	0.150	0.006 (-0.02,0.03)	0.623	0.008 (-0.02,0.03)	0.569	0.01 (-0.005,0.03)	0.150
Adjusted <sup>2</sup>	0.001 (-0.01,0.02)	0.864	0.003 (-0.01,0.02)	0.640	0.01 (-0.01,0.03)	0.158	0.006 (-0.02,0.03)	0.620	0.007 (-0.02,0.03)	0.577	0.01 (-0.005,0.03)	0.158
Bioavailable 25 hydroxivitamin D												
Crude	-0.008 (-0.03,0.01)	0.510	-0.002 (-0.02,0.02)	0.852	-0.0008 (-0.03,0.02)	0.953	-0.008 (-0.03,0.01)	0.510	-0.002 (-0.02,0.02)	0.852	-0.0008 (-0.03,0.02)	0.953
Adjusted <sup>1</sup>	0.006 (-0.01,0.02)	0.542	0.01 (-0.007,0.03)	0.231	0.01 (-0.009,0.04)	0.229	0.006 (-0.01,0.02)	0.542	0.01 (-0.007,0.03)	0.231	0.01 (-0.009,0.04)	0.229
Adjusted <sup>2</sup>	0.006 (-0.01,0.02)	0.536	0.01 (-0.007,0.03)	0.246	0.01 (-0.009,0.04)	0.250	0.005 (-0.01,0.02)	0.536	0.01 (-0.007,0.03)	0.246	0.01 (-0.01,0.04)	0.250

\* Vitamin D levels (total, free and bioavailable 25 hydroxyvitamin D) were logarithmically transformed to the base 10. Model 1 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day), smoking (never, current, past) and vitamin D intake.

**Table S20.** Association between VitD levels and BMD by menopausal status.

	Premenopausal, n=513						Postmenopausal, n=776					
	Total 25 hydroxivitamin D											
	Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )		Hip BMD (g/cm <sup>2</sup> )		Femoral neck (g/cm <sup>2</sup> )		Spine lumbar (g/cm <sup>2</sup> )	
Model	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
Crude	-0.01 (-0.05,0.03)	0.544	0.001 (-0.03,0.04)	0.950	0.02 (-0.02,0.06)	0.245	<b>0.05</b> <b>(0.01,0.08)</b>	<b>0.008</b>	<b>0.06</b> <b>(0.03,0.09)</b>	<b>&lt;0.001</b>	0.04 (-0.003,0.08)	0.037
Adjusted <sup>1</sup>	0.001 (-0.001,0.002)	0.497	0.02 (-0.01,0.06)	0.169	0.03 (-0.01,0.07)	0.116	0.0005 (-0.0009,0.002)	0.506	0.03 (-0.003,0.05)	0.075	0.02 (-0.01,0.06)	0.234
Adjusted <sup>2</sup>	0.01 (-0.02,0.05)	0.380	0.02 (-0.01,0.05)	0.182	0.03 (-0.009,0.06)	0.134	0.02 (-0.01,0.04)	0.308	0.02 (-0.004,0.05)	0.100	0.02 (-0.02,0.06)	0.262
	Free 25 hydroxivitamin D											
Crude	0.003 (-0.02,0.03)	0.836	0.004 (-0.02,0.03)	0.748	0.01 (-0.01,0.04)	0.387	0.003 (-0.02,0.03)	0.800	0.007 (-0.02,0.03)	0.558	0.02 (-0.01,0.04)	0.217
Adjusted <sup>1</sup>	0.002 (-0.02,0.02)	0.843	0.005 (-0.02,0.03)	0.666	0.01 (-0.01,0.04)	0.256	0.001 (-0.02,0.02)	0.895	0.003 (-0.02,0.02)	0.746	0.01 (-0.01,0.04)	0.256
Adjusted <sup>2</sup>	0.002 (-0.02,0.02)	0.826	0.005 (-0.02,0.03)	0.643	0.01 (-0.01,0.04)	0.275	0.001 (-0.02,0.02)	0.923	0.003 (-0.02,0.02)	0.763	0.01 (-0.01,0.04)	0.275
	Bioavailable 25 hydroxivitamin D											
Crude	-0.001 (-0.03,0.03)	0.920	0.01 (-0.02,0.04)	0.441	0.008 (-0.03,0.04)	0.649	-0.001 (-0.03,0.03)	0.920	0.01 (-0.02,0.04)	0.441	0.008 (-0.03,0.04)	0.649
Adjusted <sup>1</sup>	0.001 (-0.02,0.03)	0.955	0.009 (-0.01,0.03)	0.460	0.01 (-0.02,0.04)	0.533	0.001 (-0.02,0.03)	0.955	0.009 (-0.01,0.03)	0.460	0.01 (-0.02,0.04)	0.533
Adjusted <sup>2</sup>	0.001 (-0.02,0.03)	0.950	0.008 (-0.02,0.03)	0.499	0.01 (-0.02,0.04)	0.562	0.001 (-0.02,0.03)	0.950	0.008 (-0.02,0.03)	0.499	0.01 (-0.02,0.04)	0.562

Vitamin D levels (total, free and bioavailable 25 hydroxyvitamin D) were logarithmically transformed to the base 10. Model 1 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day) and smoking (never, smoking, former smoker). Model 2 adjusted for age groups, BMI (normal, overweight, obesity), alcohol (g/day), leisure time physical activity (active ≥30 min/day), smoking (never, current, past) and vitamin D intake.