

**Supplementary Table S1.** Demographic and clinical characteristics of the study participants

Characteristics	Non-HDC (n = 1,128)	HDC (n = 236)	P
Male	513 (45.48%)	82 (34.75%)	0.003
Age (years)	48.00 (37.00–60.00)	61.00 (54.50–68.00)	< 0.001
Smoking	386 (34.22%)	60 (25.42%)	0.009
Alcohol drinking	252 (22.42%)	33 (14.04%)	0.004
Family history of diabetes	214 (18.97%)	43 (18.22%)	0.932
Family history of hypertension	391 (34.66%)	83 (35.17%)	0.833
FPG (mmol/L)	4.66 (4.14–5.15)	8.37 (6.59–10.62)	< 0.001
SBP (mm Hg)	116.67 (108.33–123.33)	143.17 (133.33–153.33)	< 0.001
DBP (mm Hg)	75.67 (70.00–80.00)	86.00 (80.00–91.67)	< 0.001
TC (mmol/L)	4.27 (3.68–4.97)	4.71 (4.07–5.52)	< 0.001
TG (mmol/L)	1.14 (0.76–1.79)	1.87 (1.26–2.94)	< 0.001
HDL-C (mmol/L)	1.24 (1.04–1.46)	1.17 (1.00–1.39)	0.018
LDL-C (mmol/L)	2.40 (1.89–2.93)	2.57 (2.00–3.17)	0.028
BMI (kg/m <sup>2</sup> )	24.16 (21.65–26.60)	26.86 (24.93–28.98)	< 0.001
WHR	0.88 (0.83–0.93)	0.94 (0.90–0.98)	< 0.001
WC (cm)	83.00 (75.90–90.50)	92.00 (86.00–98.00)	< 0.001
25(OH)D3			0.080
VDD (< 20 ng/mL)	550 (48.76%)	133 (56.36%)	
VDI (20–30 ng/mL)	279 (24.73%)	54 (22.88%)	
VDS (> 30 ng/mL)	299 (26.51%)	49 (20.76%)	

**Note.** HDC, hypertension and diabetes comorbidity; FPG, fasting plasma glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; BMI, body mass index; WHR, waist–hip ratio; WC, waist circumference; VDD, vitamin D deficiency; VDI, vitamin D insufficiency; VDS, vitamin D sufficiency. Data are given as the mean  $\pm$  SD, *n* (%) or median (interquartile range), with the significance of differences between groups evaluated using *t* test, the  $\chi^2$  test, or Wilcoxon ranks test, respectively.

**Supplementary Table S2.** Results of association analysis of metabolic indicators with HDC risk

Indicator	OR (95% CI) <sup>a</sup>	P
<b>BMI</b>		
< 18.50	0.873 (0.192–3.974)	0.861
18.50–23.99	1	
24.00–27.99	3.396 (2.258–5.106)	< 0.001
≥ 28.00	7.553 (4.799–11.889)	< 0.001
<b>HTG<sup>b</sup></b>	3.673 (2.676–5.041)	< 0.001
<b>Abnormal WC<sup>c</sup></b>	4.368 (3.004–6.352)	< 0.001
<b>Abnormal WHR<sup>c</sup></b>	4.138 (2.724–6.284)	< 0.001
<b>Abnormal TC<sup>d</sup></b>	1.710 (1.230–2.378)	0.001
<b>Abnormal HDL-C<sup>e</sup></b>	1.352 (0.972–1.879)	0.073
<b>25(OH)D<sub>3</sub><sup>f</sup></b>		
VDD (< 20)	1.204 (0.820–1.768)	0.343
VDI (20–30)	0.827 (0.527–1.299)	0.411
VDS (> 30)	1	

**Note.** <sup>a</sup>Adjusted for age, sex, smoking, alcohol drinking, family history of HTN, and family history of diabetes. <sup>b</sup>HTG, hypertriglyceridemia (TG ≥ 2.26 mmol/L). <sup>c</sup>WC > 85 cm or waist-hip ratio WHR ≥ 0.90 for men and > 80 cm or ≥ 0.85 for women are defined as abnormal WC and abnormal WHR. <sup>d</sup>TC ≥ 5.18 mmol/L was determined to be abnormal TC. <sup>e</sup>HDL-C < 1.04 mmol/L was defined as abnormal HDL-C. <sup>f</sup>VDD-vitamin D deficiency (< 20 ng/mL); VDI-vitamin D insufficient (20–30 ng/mL); VDS-vitamin D sufficient (≥ 30 ng/mL).

**Supplementary Table S3.** The interactions between *VDR* variants and environment indicators on the HDC risk

SNPs	RERI	AP	SI
<b>rs2228570</b>			
BMI	-3.27 (-9.03-2.48)	-0.42 (0.99-0.14)	0.67 (0.44-1.04)
WC	-2.39 (-6.19-1.40)	-0.44 (-1.04-0.17)	0.65 (0.40-1.06)
WHR	-0.80 (-3.51-1.90)	-0.16 (-0.67-0.35)	0.83 (0.49-1.41)
TC	-0.04 (-1.59-1.50)	-0.02 (-0.76-0.72)	0.96 (0.25-3.71)
TG	0.61 (-1.43-2.65)	0.19 (-0.41-0.79)	1.37 (0.43-4.41)
HDL-C	-0.08 (-0.99-0.82)	-0.11 (-1.34-1.12)	1.49 (0.01-281.05)
25(OH)D3	0.18 (-0.53-0.88)	0.18 (-0.61-0.97)	0.13 (0.01-1.91)
<b>rs3847987</b>			
BMI	-0.58 (-3.28-2.12)	-0.08 (-0.48-0.31)	0.91 (0.60-1.39)
WC	0.96 (-1.04-2.97)	0.17 (-0.15-0.48)	1.25 (0.78-2.01)
WHR	2.54 (0.53-4.55)	0.41 (0.18-0.64)	1.96 (1.14-3.39)
TC	1.33 (-0.04-2.69)	0.43 (0.11-0.75)	2.76 (0.85-8.97)
TG	2.67 (0.05-5.29)	0.48 (0.18-0.77)	2.37 (1.11-5.07)
HDL-C	-1.10 (-3.12-0.93)	-0.42 (-1.13-0.29)	0.60 (0.30-1.19)
25(OH)D3	-0.59 (-1.97-0.78)	-0.28 (-0.92-0.36)	0.65 (0.29-1.46)
<b>rs2239179</b>			
BMI	-1.03 (-3.05-0.98)	-0.23 (-0.69-0.23)	0.77 (0.49-1.23)
WC	-1.47 (-3.63-0.69)	-0.32 (-0.81-0.18)	0.71 (0.45-1.13)
WHR	-2.82 (-6.23-0.60)	-0.43 (-0.94-0.07)	0.66 (0.44-0.99)
TC	-1.33 (-2.68-0.01)	-0.79 (-1.81-0.24)	0.34 (0.10-1.21)
TG	-0.34 (-2.30-1.61)	-0.10 (-0.72-0.51)	0.87 (0.40-1.91)
HDL-C	0.01 (-0.88-0.91)	0.01 (-0.63-0.65)	1.03 (0.10-10.48)
25(OH)D3	0.17 (-0.55-0.89)	0.13 (-0.41-0.66)	1.93 (0.02-152.78)
<b>rs739837</b>			
BMI	-1.44 (-4.58-1.71)	-0.19 (-0.60-0.23)	0.82 (0.55-1.22)
WC	0.58 (-1.48-2.64)	0.10 (-0.23-0.43)	1.13 (0.72-1.77)
WHR	1.70 (-0.22-3.63)	0.28 (0.01-0.55)	1.50 (0.92-2.45)
TC	1.10 (-0.18-2.38)	0.38 (0.03-0.73)	2.40 (0.74-7.76)
TG	2.01 (-0.37-4.38)	0.38 (0.05-0.72)	1.91 (0.92-3.97)
HDL-C	-0.10 (-2.96-0.97)	-0.36 (-1.01-0.28)	0.64 (0.34-1.20)
25(OH)D3	-0.58 (-1.90-0.74)	-0.28 (-0.88-0.33)	0.66 (0.31-1.40)

**Note.** SNPs: Single nucleotide polymorphisms; RERI, relative excess risk due to interaction; AP, attributable proportion due to interaction; SI, synergy index; BMI, body mass index; WC, waist circumference; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol.