Table1 Baseline socio-demographic and clinical characteristics of the study population based on serum cis-β-carotene quartiles.

Characteristic	cis-β-carotene (0.004-0.402 μmol/L)				P value
	Quartiles 1	Quartiles 2	Quartiles 3	Quartiles 4	
Participants, n	624	3845	2407	2405	
Age, years	33.4 ±18.8	33.6 ±20.0	38.3±22.6	49.0 ±22.8	<0.001
Gender					
Man	373 (59.8%)	2063 (53.7%)	1197 (49.7%)	924(38.4%)	
Woman	251 (40.2%)	1782 (46.3%)	1210 (50.3%)	1481(61.6%)	
Body Mass Index (kg/m^2)	28.49 ±6.84	27.86 ±7.42	26.52 ±6.35	25.97 ±5.39	<0.001
Systolic blood pressure (mm Hg)	118.96±17.07	118.01 ±17.74	119.33 ±19.90	124.09±23.20	<0.001
Diastolic blood pressure (mm Hg)	66.73±13.80	67.40 ±13.61	66.58 ±13.54	67.85 ±14.16	0.108
Ratio of Family income to poverty	2.10 ±1.52	2.36 ±1.57	2.46 ±1.61	2.84 ±1.64	<0.001
High school education or higher, n (%)	389(62.3%)	2516(65.43%)	1574(65.39%)	1735(72.14%)	<0.001
Waist circumference, cm	97.26±17.91	94.34±18.14	91.40 ±16.71	90.70 ±14.60	<0.001
Thigh circumference, cm	54.43 ±8.13	53.61 ±7.82	51.90 ±7.22	50.83 ±6.57	<0.001
Fasting Blood Glucose (mmol/L)	5.71 ±0.44	5.64 ±1.78	5.60 ±1.82	5.54 ±1.57	0.046

Fasting Insulin(pmol/L)	90.43 ±103.70	90.76 ±98.18	73.31 ±75.91	59.84 ±72.23	<0.001
C-peptide(mmol/L)	0.95 ±0.54	0.85 ±0.46	0.79 ±0. 45	0.72 ±0.37	<0.001
C-reactive protein(mg/dL)	0.55 ±1.31	0.44 ±0.80	0.38 ±0.78	0.34 ±0.84	<0.001
Triglyceride (mmol/L)	1.67 ±2.13	1.50 ±1.29	1.46 ±1.12	1.41 ±1.22	<0.001
LDL-cholesterol (mmol/L)	2.57 ±0.99	2.67 ±0.85	2.86 ±0.90	3.14 ±0.99	<0.001
HOMA-IR	3.48 ±4.88	3.47 ±5.03	2.86 ±4.65	2.28 ±3.60	<0.001
HOMA-B	170.87 ±742.09	138.63±73.84	118.98±218.06	90.45 ±245.77	<0.001
α-carotene(μmol/L)	0.02 ±0.02	0.03 ±0.03	0.06 ±0.04	0.15 ±0.17	<0.001
trans-b-carotene (μmol/L)	0.08 ±0.04	0.14 ±0.06	0.26 ±0.08	0.67 ±0.50	<0.001
Combined Lutein/zeaxanthin (μmol/L)	0.20 ±0.08	0.22 ±0.09	0.27 ±0.12	0.37 ±0.18	<0.001
trans-lycopene (μmol/L)	0.33 ±0.18	0.40 ±0.19	0.43 ±0.20	0.45 ±0.22	<0.001

Note: The HOMA-IR was calculatedusing the formula: fasting insulin (pmol/l) ×FPG (mmol/l)/156.3. Insulin resistance was defined as HOMA-IR ≥2.5 [23].HOMA-B was calculated according to the formula: (2.9 ×fasting insulin [pmol/l])/(FPG [mmol/l -3.5)].Values are mean ±SD or n (%)

Table 2. Correlation between cis-β-carotene in blood biochemistry

Variables	cis-β-carotene(μmol/L)		Fasting blood glucose(mmol/L)		Triglyceride (mmol/L)		Insulin(pmol/L)		SBP average		DBP average		HOMA-R	
	r value	p value	r value	p value	r value	p value	r value	p value	r value	p value	r value	p value	r value	p value
cis-β-carotene(μmol/L)	1		-0.034	<0.001	-0.041	<0.001	-0.113	<0.001	0.109	<0.001	-0.003	0.831	-0.088	<0.001
Fasting blood glucose(mmol/L)	-0.034	0.339	1		0.240	<0.001	0.220	<0.001	0.220	<0.001	0.072	<0.001	0.481	<0.001
Triglyceride (mmol/L)	-0.041	<0.001	0.240	<0.001	1		0.174	<0.001	0.145	<0.001	0.098	<0.001	0.198	<0.001
Insulin: SI(pmol/L)	-0.113	<0.001	0.220	<0.001	0.174	<0.001	1		0.045	<0.001	-0.008	<0.001	0.895	<0.001
SBP average	0.109	<0.001	0.22	<0.001	0.145	<0.001	0.045	<0.001	1		0.331	<0.001	0.094	<0.001
DBP average	-0.003	0.831	0.072	<0.001	0.098	<0.001	-0.008	0.511	0.331	<0.001	1		0.005	0.679
HOMA-R	-0.088	<0.001	0.481	<0.001	0.198	<0.001	0.895	<0.001	0.094	<0.001	0.005	0.679	1	

Notes: Pearson correlation was calculated to assess the strength of relationship between cis-β-carotene and blood biochemistry.

Table 3The associated between serum Fasting Glucose(mmol/L) and cis-β-carotene (µmol/L)

Per 1 µmol/L increased in serum cis-β-carotene	Model 1 β (95% CI) P Value	Model 2 β (95% CI) P Value	Model 3 β (95% CI) P Value
Participants	9281	8537	5742
Fasting Glucose(mmol/L)	0.10(0.009,0.011) <0.001	0.001(-0.001,0.003) 0.537	0.0130.009,0.017) <0.001
HOMA-IR	0.022(0.021,0.022) <0.001	0.005(0.003, 0.007) <0.001	0.017(0.014, 0.021) <0.001
HOMA-B	0.022(0.021,0.022) <0.001	0.004(0.002, 0.006) <0.001	0.013(0.009, 0.017) <0.001
Triglyceride(mmol)	0.010(0.009,0.011) <0.001	0.04(0.003, 0.006) <0.001	0.013(0.009, 0.017) <0.001
Insulin(pmol/L)	0.023(0.022,0.024) <0.001	0.006(0.004, 0.008) <0.001	0.009(0.006, 0.012) <0.001

Notes: Model 1 adjust for: no covariates. Model 2 adjust for: age, gender, ratio of family income to poverty. Model 3 adjust for: systolic blood pressure, diastolic blood pressure, BMI, LDL-cholesterol and C-reaction protein. In the subgroup analysis stratified by gender and educational level.

Table-4. The activity of cardiac mitochondrial electron transport chain complex(ETC)

Activity (nmol/min/mg mt prot)	complex I	complex II	complexIII	complex IV
Control	4.81±0.71	0.61±0.21	1.97±0.26	2.57±0.41
4 weeks DM	2.76±0.31*	0.52±0.17	1.14±0.0.17*	2.37±0.40*
4 weeks DM +β-carotene	3.46±0.46#	0.52±0.17	0.75±0.22#	1.73±0.28#
8 weeks DM	1.85±0.44*	0.53±0.17	0.69±0.15*	2.26±0.32*
8 weeks DM +β-carotene	3.91±0.61#	0.56±0.19	1.31±0.21#▽	2.01±0.29#▽

Notes:*P<0.05 vs. control group; # P<0.05 vs. 4 weeks DM; ▽P<0.05 vs. 8 weeks DM. Data are shown as means ±SEM (n = 10).