

Supplementary Tables

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Protective effect of Provitamin A Dietary Carotenoid Intake on Overweight/Obesity and their relation to Inflammatory and Oxidative Stress Biomarkers - A Case-Control Study

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Supplementary Tables

Supplementary Table 1: Study Population Characteristics - Sociodemographic Variables in Overweight/Obese and Normal-Weight Groups Defined by BSA[†] (n=1605)*¹.

	Normal Weight (n = 787)	Overweight/Obese (n = 818)	p-value**
Age (years)	48.40 (20.76)	48.50 (19.75)	0.906
BMI (kg/m ²)	22.70 (4.09)	26.63 (4.48)	<0.001
Sex (M/F)	537/250	261/557	<0.001
Education			
Diploma/ low literate	534	536	0.323
Higher than diploma	253	282	
Marital Status			
Single	143	130	0.377
Married	591	624	
Other	53	64	
Regular physical activity			
Yes	215	182	0.019
No	572	636	
Smoking status			
Yes	125	136	0.687
No	662	682	
History of CVD			
Yes	137	176	0.038
No	650	642	
History of diabetes			
Yes	213	223	0.929
No	574	595	
History of hypertension			
Yes	366	461	<0.001
No	421	357	

*For continuous variables, median (IQR) values are shown. For categorical variables, frequencies are displayed.

[†]BSA-based classification considered participants normal weight if BSA was ≤ 1.91 m² and ≤ 1.71 m² for men and women, respectively.

**Two-sided p-values were derived from chi-square tests for categorical variables and Mann-Whitney U-test for continuous variables.

Significant p-values ($p < 0.05$) are shown in **bold**.

Abbreviations: BSA = body surface area, BMI = body mass index, M = male, F = female, CVD = cardiovascular disease.

- Vahid, F., D. Rahmani, and S.H. Davoodi, The correlation between serum inflammatory, antioxidant, glucose handling biomarkers, and Dietary Antioxidant Index (DAI) and the role of DAI in obesity/overweight causation: a population-based case-control study. *Int J Obes (Lond)*, 2021. 45(12): p. 2591-2599.

Supplementary Table 2: Dietary intake of fruits, vegetables, and total energy and carotenoids intake ($\mu\text{g}/1000$ kcal/day) of the study population ($n=1605$)*.

	Total (n = 1605)	Overweight/ Obesity*** (n = 851)	Normal Weight*** (n = 754)	p-value [†]	Male (n = 798)	Female (n = 807)	p-value [†]
Total energy intake (kcal/day)	2828 (784)	2863 (803)	2786 (790)	0.028	2832 (841)	2824 (731)	0.657
Fruits (g/day)	410 (149)	414 (151)	408 (151)	0.795	408 (150)	410 (153)	0.366
Vegetables (g/day)	382 (180)	372 (171)	400 (188.81)	<0.001	382 (189)	382 (180)	0.586
Carotenoid Intake ($\mu\text{g}/1000$ kcal/day)**							
α-Carotene	1246 (1322)	1163 (1229)	1332 (1386)	0.006	1204 (1295)	1287 (1360)	0.184
β-Carotene	3390 (2511)	3230 (2278)	3523 (2702)	0.004	3410 (2525)	3386 (2492)	0.864
β-Cryptoxanthin	92.21 (57.80)	92 (53)	92 (60)	0.620	93.89 (58.12)	90.17 (56.76)	0.250
ΣProvitamin A	4747 (3713)	4484 (3508)	5089 (3779)	<0.001	4736 (3728)	4766 (3696)	0.670
Lutein + Zeaxanthin	689 (460)	666 (459)	710 (474)	0.008	683 (438)	697 (469)	0.216
Lycopene	1735 (1490)	1724 (1464)	1758 (1497)	0.786	1710 (1353)	1748 (1679)	0.075
Phytoene	2715 (1574)	2683 (1539)	2762 (1689)	0.108	2746 (1619)	2664 (1552)	0.149
Phytofluene	918 (529)	915 (490)	929 (570)	0.162	927 (554)	909 (509)	0.149
Violaxanthin	544 (267)	530 (260)	562 (273)	0.002	540 (266)	547 (270)	0.400
Neoxanthin	144 (77.85)	141 (76)	150 (79)	0.010	142 (76)	145 (78)	0.322
Astaxanthin	0.95 (2.62)	0.87 (2.45)	1.07 (2.74)	0.001	0.95 (2.67)	0.94 (2.56)	0.729
ΣNon-Provitamin A	7031 (3693)	6967 (3533)	7098 (3865)	0.183	6969 (3767)	7145 (3616)	0.603
ΣTotal Carotenoids	12324 (6834)	11970 (6446)	12639 (7083)	0.009	12371 (6858)	12269 (6796)	0.677

*Due to the non-normal distribution of the data, median (interquartile range) values are displayed.

**Carotenoid intakes are adjusted for daily energy intake.

***Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI <25 kg/m² and overweight/obesity is defined as BMI \geq 25kg/m².

[†]Two-sided p-values were derived from nonparametric Mann-Whitney U-tests.

Statistically significant p-values ($p < 0.05$) are shown in **bold**.

Supplementary Table 3. Dietary intake of total carotenoid intake[†] of the study population (n=1605)*.

	Total (n = 1605)	Overweight/ Obese		p- value**	Male (n = 798)	Female (n = 807)	p-value**
		Obese (n = 851)	Normal Weight (n = 754)				
α-Carotene (μg/day)	3704 (3392)	3525 (3418)	3762 (3494)	0.028	3531 (3306)	3739 (3538)	0.173
β-Carotene (μg/day)	9647 (6158)	9502 (5537)	9989 (6556)	0.031	9647 (6059)	9644 (6347)	0.801
β-Cryptoxanthin (μg/day)	265 (133)	266 (131)	265 (138)	0.571	273 (135)	262 (128)	0.092
Σ Provitamin A (μg/day)	14257 (8757)	13512 (8835)	14680 (9209)	0.004	14164 (8445)	14310 (8932)	0.620
Lutein + zeaxanthin (μg/day)	1992 (1100)	1971 (1127)	2012 (1109)	0.115	1988 (1055)	1999 (1181)	0.298
Lycopene (μg/day)	5093 (4051)	5187 (4072)	4915 (4078)	0.232	4846 (3728)	5187 (4455)	0.057
Phytoene (μg/day)	7656 (3574)	7611 (3552)	7665 (3713)	0.503	7730 (4135)	7608 (3484)	0.090
Phytofluene (μg/day)	2598 (1236)	2594 (1234)	2599 (1245)	0.657	2622 (1297)	2591 (1153)	0.088
Violaxanthin (μg/day)	1575 (674)	1551 (651)	1594 (669)	0.065	1563 (607)	1584 (719)	0.556
Neoxanthin (μg/day)	402 (193)	402 (194)	409 (195)	0.175	400 (189)	411 (193)	0.394
Astaxanthin (μg/day)	2.50 (8.65)	2.50 (8.65)	3.75 (7.50)	0.003	2.50 (8.65)	2.50 (8.65)	0.669
Σ Non-provitamin A (μg/day)	19425 (8147)	19425 (8034)	19421 (8322)	0.991	19418 (8192)	19622 (8151)	0.605
Σ Total carotenoids (μg/day)	34184 (16615)	33776 (15896)	35082 (17424)	0.071	34114. (17053)	34378 (15452)	0.559

*Due to the non-normal distribution of the data, median (IQR) values are displayed. Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI <25 kg/m² and overweight/obesity is defined as BMI ≥25 kg/m².

Two-sided p-values were derived from nonparametric Mann-Whitney U-tests. Statistically significant p-values (p <0.05) are shown in **bold.

[†] Not adjusted for energy intake values.

Supplementary Tables

Supplementary Table 4: Spearman rank correlations between the intake of carotenoids, total energy intake, and vegetables and fruits*.

	Total Carotenoid Intake ($\mu\text{g}/\text{day}$)						Carotenoids Intake Adjusted for Daily Energy Intake ($\mu\text{g}/1000 \text{ kcal}$)					
	Total Energy Intake (kcal/day)		Vegetables (g/day)		Fruits (g/day)		Total Energy Intake (kcal/day)		Vegetables (g/day)		Fruits (g/day)	
	r_s	p-value	r_s	p-value	r_s	p-value	r_s	p-value	r_s	p-value	r_s	p-value
α -Carotene	-0.064	0.010	0.239	< 0.001	-0.019	0.435	-0.311	< 0.001	0.228	< 0.001	-0.011	0.645
β -Carotene	-0.057	0.023	0.294	< 0.001	0.118	< 0.001	-0.411	< 0.001	0.272	< 0.001	0.111	< 0.001
β -Cryptoxanthin	-0.013	0.590	0.103	< 0.001	0.520	< 0.001	-0.447	< 0.001	0.095	< 0.001	0.473	< 0.001
Lutein + zeaxanthin	-0.078	0.002	0.249	< 0.001	0.325	< 0.001	-0.467	< 0.001	0.230	< 0.001	0.290	< 0.001
Lycopene	-0.028	0.258	0.448	< 0.001	0.055	0.028	-0.349	< 0.001	0.428	< 0.001	0.062	0.012
Phytoene	-0.047	0.060	0.373	< 0.001	0.588	< 0.001	-0.522	< 0.001	0.322	< 0.001	0.500	< 0.001
Phytofluene	-0.053	0.032	0.366	< 0.001	0.587	< 0.001	-0.531	< 0.001	0.311	< 0.001	0.499	< 0.001
Violaxanthin	-0.014	0.577	0.358	< 0.001	0.082	0.001	-0.551	< 0.001	0.288	< 0.001	0.088	< 0.001
Neoxanthin	-0.036	0.150	0.398	< 0.001	0.133	< 0.001	-0.543	< 0.001	0.326	< 0.001	0.121	< 0.001
Astaxanthin	-0.003	0.900	0.017	0.498	-0.043	0.083	-0.196	< 0.001	0.022	0.379	-0.046	0.067
Σ Provitamin A	-0.062	0.012	0.275	< 0.001	0.080	< 0.001	-0.398	< 0.001	0.256	< 0.001	0.078	< 0.001
Σ Non-provitamin A	-0.061	0.015	0.529	< 0.001	0.462	< 0.001	-0.575	< 0.001	0.436	< 0.001	0.383	< 0.001
Σ Total carotenoids	-0.081	0.001	0.496	< 0.001	0.293	< 0.001	-0.551	< 0.001	0.420	< 0.001	0.246	< 0.001

*Spearman correlations were performed due to the non-normal distribution of the data. Spearman correlation coefficients (r_s) and the corresponding two-sided p-values are displayed. Statistically significant p-values ($p < 0.05$) are shown in **bold**.

Supplementary Tables

Supplementary Table 5: Spearman rank correlations between individual carotenoids*.

	Total Carotenoid Intakes																							
	ΣProvitamin A		ΣNon-provitamin A		ΣTotal Carotenoids		α-Carotene		β-Carotene		β-Cryptoxanthin		Lutein + zeaxanthin		Lycopene		Phytoene		Phytofluene		Violaxanthin		Neoxanthin	
	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value
β-Carotene	0.978	<0.001	0.325	<0.001	0.875	<0.001	0.844	<0.001																
β-Cryptoxanthin	0.083	0.001	0.393	<0.001	0.248	<0.001	-0.006	0.823	0.099	<0.001														
Lutein + zeaxanthin	0.184	<0.001	0.467	<0.001	0.394	<0.001	0.086	0.001	0.222	<0.001	0.273	<0.001												
Lycopene	0.048	0.052	0.690	<0.001	0.390	<0.001	0.031	0.215	0.059	0.017	0.131	<0.001	0.102	<0.001										
Phytoene	0.317	<0.001	0.854	<0.001	0.666	<0.001	0.177	<0.001	0.372	<0.001	0.407	<0.001	0.296	<0.001	0.355	<0.001								
Phytofluene	0.374	<0.001	0.832	<0.001	0.699	<0.001	0.236	<0.001	0.428	<0.001	0.407	<0.001	0.295	<0.001	0.316	<0.001	0.994	<0.001						
Violaxanthin	0.035	0.157	0.228	<0.001	0.156	<0.001	-0.034	0.179	0.060	0.016	0.318	<0.001	0.460	<0.001	-0.031	0.215	0.066	0.008	0.063	0.012				
Neoxanthin	0.055	0.029	0.206	<0.001	0.154	<0.001	-0.003	0.889	0.080	0.001	0.169	<0.001	0.456	<0.001	-0.037	0.133	0.064	0.010	0.060	0.015	0.867	<0.001		
Astaxanthin	-0.050	0.045	-0.402	0.094	-0.055	0.026	-0.039	0.120	-0.057	0.022	-0.067	0.007	-0.034	0.175	0.028	0.262	-0.073	0.003	-0.085	0.001	-0.053	0.034	-0.018	0.469
ΣProvitamin A			0.273	<0.001	0.835	<0.001	0.923	<0.001																
ΣNon-provitamin A	0.273	<0.001			0.714	<0.001	0.145	<0.001																
ΣTotal carotenoids	0.835	<0.001	0.714	<0.001			0.699	<0.001																
	Adjusted for Energy Intake																							
	ΣProvitamin A/1000 kcal		ΣNon-Provitamin A/1000 kcal		ΣTotal Carotenoids/1000 kcal		α-Carotene/ 1000 kcal		β-Carotene/ 1000 kcal		β-Cryptoxanthin/ 1000 kcal		Lutein + zeaxanthin/ 1000 kcal		Lycopene/ 1000 kcal		Phytoene/ 1000 kcal		Phytofluene/ 1000 kcal		Violaxanthin/ 1000 kcal		Neoxanthin/ 1000 kcal	
	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value	r _s	p-value
β-Carotene/1000 kcal	0.982	<0.001	0.486	<0.001	0.878	<0.001	0.860	<0.001																
β-Cryptoxanthin/1000 kcal	0.249	<0.001	0.559	<0.001	0.436	<0.001	0.134	<0.001	0.269	<0.001														
Lutein + zeaxanthin/1000 kcal	0.339	<0.001	0.559	<0.001	0.548	<0.001	0.220	<0.001	0.377	<0.001	0.421	<0.001												
Lycopene/1000 kcal	0.184	<0.001	0.736	<0.001	0.506	<0.001	0.138	<0.001	0.199	<0.001	0.276	<0.001	0.258	<0.001										
Phytoene/1000 kcal	0.462	<0.001	0.901	<0.001	0.769	<0.001	0.312	<0.001	0.511	<0.001	0.565	<0.001	0.463	<0.001	0.476	<0.001								
Phytofluene/1000 kcal	0.508	<0.001	0.888	<0.001	0.792	<0.001	0.361	<0.001	0.556	<0.001	0.569	<0.001	0.465	<0.001	0.445	<0.001	0.996	<0.001						
Violaxanthin/1000 kcal	0.259	<0.001	0.470	<0.001	0.416	<0.001	0.158	<0.001	0.284	<0.001	0.502	<0.001	0.607	<0.001	0.168	<0.001	0.343	<0.001	0.347	<0.001				
Neoxanthin/1000	0.259	<0.001	0.446	<0.001	0.402	<0.001	0.169	<0.001	0.284	<0.001	0.371	<0.001	0.596	<0.001	0.162	<0.001	0.326	<0.001	0.329	<0.001	0.904	<0.001		

Supplementary Table 6: Logistic regression models for association between dietary carotenoid intake[†] and the odds of overweight/obesity*.

	Crude Model				Model 2**				Model 3***			
	95% CI				95% CI				95% CI			
	OR (Exp(B))	Lower	Upper	p-value	OR (Exp(B))	Lower	Upper	p-value	OR (Exp(B))	Lower	Upper	p-value
α-Carotene	0.686	0.516	0.911	0.009	0.698	0.520	0.936	0.016	0.745	0.551	1.006	0.054
β-Carotene	0.588	0.394	0.877	0.009	0.632	0.419	0.953	0.028	0.717	0.466	1.104	0.131
β-Cryptoxanthin	0.868	0.542	1.392	0.557	0.790	0.485	1.288	0.344	1.018	0.596	1.737	0.949
∑Provitamin A	0.557	0.381	0.814	0.002	0.590	0.399	0.871	0.008	0.655	0.436	0.983	0.041
Lutein + zeaxanthin	0.556	0.354	0.875	0.011	0.697	0.435	1.118	0.134	0.845	0.510	1.399	0.513
Lycopene	1.086	0.750	1.572	0.663	1.165	0.793	1.711	0.437	1.472	0.971	2.232	0.068
Phytoene	0.589	0.338	1.025	0.061	0.493	0.276	0.880	0.017	0.659	0.321	1.354	0.257
Phytofluene	0.618	0.353	1.081	0.092	0.508	0.283	0.911	0.023	0.691	0.337	1.417	0.313
Violaxanthin	0.428	0.233	0.788	0.006	0.581	0.307	1.100	0.095	0.701	0.362	1.354	0.290
Neoxanthin	0.466	0.257	0.844	0.012	0.673	0.363	1.248	0.209	0.850	0.443	1.629	0.624
Astaxanthin	0.815	0.723	0.918	0.001	0.862	0.761	0.975	0.019	0.859	0.759	0.973	0.017
∑Non-provitamin A	0.618	0.333	1.149	0.128	0.628	0.330	1.195	0.156	1.053	0.468	2.365	0.901
∑Total carotenoids	0.489	0.281	0.854	0.012	0.525	0.296	0.930	0.027	0.684	0.355	1.316	0.255

*Binary logistic regression analysis was performed with the odds of overweight/obesity as the dependent variable (0 = normal weight, 1 = overweight/obese). Continuous variables were log-transformed. Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI <25 kg/m² and overweight/obesity is defined as BMI ≥25 kg/m². [†]Carotenoid intake was adjusted for daily energy intake and expressed as μg/1000 kcal.

** Model 2 adjusted for the following variables: age (y), sex (male/ female), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension).

***Model 3 was adjusted for the same variables as Model 2 with the addition of fruit and vegetable intake (fruit (g/day) + vegetables (g/day)).

Significant p-values (p <0.05) are shown in **bold**.

Abbreviations: OR = odds ratio, CI = confidence interval.

Supplementary Tables

Supplementary Table 7: Associations between dietary intake of carotenoids and overweight/obesity based on BSA classification (sensitivity analysis)*.

	OR (Exp(B))	95% CI		p-value**
		Lower	Upper	
α-Carotene	0.735	0.537	1,008	0.056
β-Carotene	0.634	0.402	0.998	0.049
β-Cryptoxanthin	0.942	0.537	1,650	0.833
∑ Provitamin A	0.627	0.409	0.961	0.032
Lutein + zeaxanthin	1,126	0.665	1,906	0.658
Lycopene	1,448	0.936	2,240	0.096
Phytoene	0.891	0.418	1,896	0.764
Phytofluene	0.844	0.397	1,797	0.661
Violaxanthin	0.552	0.277	1,100	0.091
Neoxanthin	0.738	0.374	1,455	0.381
Astaxanthin	0.952	0.836	1,084	0.460
∑ Non-provitamin A	1,144	0.489	2,676	0.756
∑ Total carotenoids	0.668	0.335	1,333	0.252

*Binary logistic regression analysis was performed with the odds of overweight/obesity as the dependent variable (0 = normal weight, 1 = overweight/obese). BSA-based classification considered participants to be normal weight if BSA was $\leq 1.91 \text{ m}^2$ and $\leq 1.71 \text{ m}^2$ for men and women, respectively. Carotenoid intake was adjusted for daily energy intake and expressed as $\mu\text{g}/1000 \text{ kcal}$. Continuous variables were log-transformed. The model was adjusted for the following variables: age (y), sex (male/ female), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension) and fruit and vegetable intake (fruit (g/day) + vegetables (g/day)).

Statistically significant p-values ($p < 0.05$) are shown in **bold.

Abbreviations: OR = odds ratio, CI = confidence interval, BSA = body surface area.

Supplementary Table 8: Association between dietary intake of carotenoids and overweight/obesity based on BMI in sex groups (sensitivity analysis)*.

	Women (n= 807)				Men (n= 798)			
	OR (Exp(B))	95% CI		p-value**	OR (Exp(B))	95% CI		p-value**
		Lower	Upper			Lower	Upper	
α-Carotene	0.658	0.428	1.011	0.056	0.844	0.551	1.293	0.435
β-Carotene	0.755	0.406	1.406	0.376	0.668	0.364	1.227	0.193
β-Cryptoxanthin	1.355	0.630	2.912	0.436	0.757	0.355	1.613	0.471
Σ Provitamin A	0.621	0.345	1.116	0.111	0.677	0.383	1.199	0.182
Lutein + zeaxanthin	0.720	0.348	1.489	0.375	0.983	0.484	1.996	0.962
Lycopene	1.504	0.843	2.683	0.167	1.486	0.809	2.728	0.201
Phytoene	0.675	0.234	1.951	0.468	0.675	0.251	1.812	0.435
Phytofluene	0.744	0.257	2.151	0.585	0.675	0.252	1.807	0.434
Violaxanthin	0.856	0.332	2.205	0.747	0.496	0.195	1.262	0.141
Neoxanthin	0.778	0.301	2.008	0.603	0.808	0.326	2.001	0.644
Astaxanthin	0.920	0.769	1.099	0.357	0.800	0.671	0.954	0.013
Σ Non-provitamin A	1.184	0.368	3.810	0.777	0.963	0.310	2.995	0.949
Σ Total carotenoids	0.660	0.254	1.715	0.394	0.695	0.279	1.735	0.436

* Binary logistic regression analysis was performed with the odds of overweight/obesity as the dependent variable (0 = normal weight, 1 = overweight/obese). Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI <25 kg/m² and overweight/obesity is defined as BMI ≥25 kg/m². Carotenoid intake was adjusted for daily energy intake and expressed as μg/1000 kcal. Continuous variables were log-transformed. The model was adjusted for the following variables: age (y), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension) and fruit and vegetable intake (fruit (g/day) + vegetables (g/day)).

Statistically significant p-values (p < 0.05) are shown in **bold.

Abbreviations: OR = odds ratio, CI = confidence interval.

Supplementary Table 9. Association between dietary intake of carotenoids and overweight/obesity based on BMI, separately adjusted either for fruits or for vegetables (sensitivity analysis)*.

	Fruit				Vegetables			
	OR (Exp(B))	95% CI		p-value	OR (Exp(B))	95% CI		p-value
		Lower	Upper			Lower	Upper	
α-Carotene	0.696	0.519	0.934	0.016	0.772	0.568	1.051	0.100
β-Carotene	0.641	0.424	0.968	0.034	0.739	0.479	1.140	0.171
β-Cryptoxanthin	0.848	0.482	1.492	0.567	0.847	0.518	1.386	0.509
Σ Provitamin A	0.596	0.403	0.880	0.009	0.675	0.448	1.018	0.061
Lutein + zeaxanthin	0.723	0.440	1.188	0.200	0.794	0.491	1.286	0.349
Lycopene	1.183	0.804	1.740	0.394	1.595	1.041	2.446	0.032
Phytoene	0.453	0.228	0.900	0.024	0.610	0.331	1.126	0.114
Phytofluene	0.474	0.238	0.945	0.034	0.629	0.340	1.163	0.139
Violaxanthin	0.596	0.314	1.131	0.113	0.728	0.375	1.411	0.347
Neoxanthin	0.695	0.372	1.297	0.253	0.883	0.459	1.696	0.708
Astaxanthin	0.861	0.760	0.975	0.018	0.862	0.761	0.976	0.019
Σ Non-provitamin A	0.661	0.325	1.341	0.251	0.926	0.452	1.896	0.833
Σ Total carotenoids	0.539	0.299	0.972	0.040	0.699	0.370	1.321	0.270

*Binary logistic regression analysis was performed with the odds of overweight/obesity as the dependent variable (0 = normal weight, 1 = overweight/obese). Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI <25 kg/m² and overweight/obesity is defined as BMI ≥25 kg/m². Carotenoid intake was adjusted for daily energy intake and expressed as μg/1000 kcal. Continuous variables were log-transformed. The model was adjusted for the following variables: age (y), sex, marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension) and either fruit or vegetable intake.

Statistically significant p-values (p < 0.05) are shown in **bold**.

Abbreviations: OR = odds ratio, CI = confidence interval.

Supplementary Tables

Supplementary Table 10. Association between dietary carotenoid intake and biomarkers (anthropometric and serum measurements) based on linear regression –crude models*.

	α-Carotene						β-Carotene						β-Cryptoxanthin						Provitamin A					
	95% CI						95% CI						95% CI						95% CI					
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m²)	-0.008	0.073	-0.016	0.001	0.002	0.001	-0.010	0.100	-0.022	0.002	0.002	0.001	-0.002	0.828	-0.016	0.012	0.000	-0.001	-0.011	0.045	-0.023	0.000	0.003	0.002
WC (cm)	-0.013	0.023	-0.024	-0.002	0.003	0.003	-0.017	0.034	-0.033	-0.001	0.003	0.002	-0.006	0.560	-0.024	0.013	0.000	0.000	-0.018	0.015	-0.033	-0.004	0.004	0.003
FBG (mg/dL)	0.006	0.250	-0.004	0.016	0.001	0.000	0.005	0.534	-0.010	0.019	0.000	0.000	0.004	0.606	-0.013	0.021	0.000	0.000	0.005	0.428	-0.008	0.019	0.000	0.000
Insulin (mIU/mL)	-0.014	0.440	-0.050	0.022	0.000	0.000	-0.028	0.279	-0.079	0.023	0.001	0.000	-0.010	0.748	-0.070	0.050	0.000	-0.001	-0.022	0.372	-0.070	0.026	0.000	0.000
HOMA-IR	-0.008	0.689	-0.049	0.032	0.000	-0.001	-0.024	0.419	-0.081	0.034	0.000	0.000	-0.005	0.876	-0.073	0.062	0.000	-0.001	-0.016	0.551	-0.071	0.038	0.000	0.000
HDL-c (mg/dL)	0.003	0.689	-0.013	0.019	0.000	-0.001	0.001	0.916	-0.021	0.024	0.000	-0.001	0.011	0.439	-0.016	0.037	0.000	0.000	0.003	0.778	-0.018	0.025	0.000	-0.001
LDL-c (mg/dL)	-0.012	0.183	-0.029	0.006	0.001	0.000	-0.010	0.427	-0.034	0.015	0.000	0.000	-0.003	0.858	-0.032	0.026	0.000	-0.001	-0.012	0.321	-0.035	0.011	0.001	0.000
TC (mg/dL)	-0.007	0.270	-0.019	0.005	0.001	0.000	-0.004	0.650	-0.021	0.013	0.000	0.000	-0.003	0.762	-0.023	0.017	0.000	-0.001	-0.005	0.508	-0.021	0.011	0.000	0.000
TG (mg/dL)	-0.014	0.370	-0.045	0.017	0.001	0.000	-0.009	0.677	-0.052	0.034	0.000	-0.001	-0.023	0.380	-0.074	0.028	0.000	0.000	-0.013	0.533	-0.054	0.028	0.000	0.000
SBP (mmHg)	-0.003	0.488	-0.011	0.005	0.000	0.000	-0.004	0.519	-0.015	0.008	0.000	0.000	-0.013	0.057	-0.027	0.000	0.002	0.002	-0.004	0.458	-0.015	0.007	0.000	0.000
DBP (mmHg)	-0.003	0.540	-0.011	0.006	0.000	0.000	-0.005	0.415	-0.016	0.007	0.000	0.000	-0.015	0.031	-0.028	-0.001	0.003	0.002	-0.004	0.421	-0.015	0.006	0.000	0.000
hs-CRP (mg/dL)	0.012	0.437	-0.019	0.043	0.000	0.000	0.015	0.486	-0.028	0.059	0.000	0.000	-0.001	0.963	-0.053	0.050	0.000	-0.001	0.015	0.464	-0.026	0.056	0.000	0.000
IL-6 (pg/mL)	-0.074	< 0.001	-0.115	-0.033	0.008	0.007	-0.088	0.003	-0.146	-0.030	0.005	0.005	-0.100	0.005	-0.168	-0.031	0.005	0.004	-0.092	0.001	-0.147	-0.037	0.007	0.006
IL-1β (pg/mL)	-0.070	< 0.001	-0.105	-0.035	0.009	0.009	-0.110	< 0.001	-0.159	-0.060	0.012	0.011	-0.118	< 0.001	-0.176	-0.059	0.010	0.009	-0.103	< 0.001	-0.149	-0.056	0.011	0.011
TNF-α (pg/mL)	-0.043	0.041	-0.084	-0.002	0.003	0.002	-0.066	0.026	-0.124	-0.008	0.003	0.002	-0.077	0.027	-0.146	-0.009	0.003	0.002	-0.063	0.025	-0.117	-0.008	0.003	0.003
IL-10 (pg/mL)	0.055	0.017	0.010	0.100	0.004	0.003	0.099	0.002	0.036	0.162	0.006	0.005	0.075	0.050	0.000	0.150	0.002	0.002	0.089	0.003	0.030	0.149	0.005	0.005
IL-4 (pg/mL)	-0.009	0.786	-0.072	0.054	0.000	-0.001	-0.012	0.798	-0.101	0.077	0.000	-0.001	-0.105	0.052	-0.210	0.001	0.002	0.002	-0.013	0.767	-0.097	0.072	0.000	-0.001
TAC (μM)	0.078	0.004	0.026	0.131	0.005	0.005	0.101	0.008	0.026	0.175	0.004	0.004	0.084	0.062	-0.004	0.172	0.002	0.002	0.101	0.005	0.031	0.171	0.005	0.004
MDA (μM)	0.011	0.559	-0.027	0.050	0.000	0.000	0.002	0.956	-0.052	0.055	0.000	-0.001	-0.036	0.266	-0.100	0.028	0.001	0.000	0.004	0.866	-0.047	0.055	0.000	-0.001
	Lutein + Zeaxanthin						Lycopene						Phytoene						Phytofluene					
	95% CI						95% CI						95% CI						95% CI					
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m²)	-0.003	0.711	-0.016	0.011	0.000	-0.001	0.004	0.497	-0.007	0.015	0.000	0.000	-0.004	0.619	-0.021	0.012	0.000	0.000	-0.003	0.716	-0.020	0.013	0.000	-0.001
WC (cm)	-0.012	0.174	-0.030	0.005	0.001	0.001	0.010	0.162	-0.004	0.025	0.001	0.001	0.000	0.986	-0.022	0.022	0.000	-0.001	-0.001	0.935	-0.023	0.021	0.000	-0.001
FBG (mg/dL)	-0.002	0.782	-0.018	0.014	0.000	-0.001	0.007	0.278	-0.006	0.021	0.001	0.000	0.004	0.687	-0.016	0.024	0.000	-0.001	0.004	0.663	-0.016	0.025	0.000	-0.001
Insulin (mIU/mL)	0.012	0.693	-0.046	0.069	0.000	-0.001	0.014	0.567	-0.034	0.061	0.000	0.000	-0.030	0.411	-0.101	0.041	0.000	0.000	-0.032	0.378	-0.104	0.039	0.000	0.000

Food and Function

Supplementary Tables

HOMA-IR	0.009	0.778	-0.055	0.074	0.000	-0.001	0.021	0.435	-0.032	0.074	0.000	0.000	-0.026	0.528	-0.105	0.054	0.000	0.000	-0.028	0.499	-0.108	0.052	0.000	0.000
HDL-c (mg/dL)	0.027	0.041	0.001	0.052	0.003	0.002	0.019	0.085	-0.003	0.040	0.002	0.001	0.039	0.016	0.007	0.070	0.004	0.003	0.037	0.023	0.005	0.069	0.003	0.003
LDL-c (mg/dL)	0.000	0.993	-0.028	0.028	0.000	-0.001	-0.007	0.554	-0.030	0.016	0.000	0.000	-0.019	0.276	-0.053	0.015	0.001	0.000	-0.019	0.282	-0.053	0.015	0.001	0.000
TC (mg/dL)	0.000	0.971	-0.019	0.019	0.000	-0.001	-0.006	0.438	-0.022	0.009	0.000	0.000	-0.012	0.321	-0.035	0.012	0.001	0.000	-0.012	0.337	-0.035	0.012	0.001	0.000
TG (mg/dL)	-0.038	0.128	-0.087	0.011	0.001	0.001	0.006	0.785	-0.035	0.046	0.000	-0.001	-0.028	0.356	-0.089	0.032	0.001	0.000	-0.028	0.363	-0.089	0.033	0.001	0.000
SBP (mmHg)	-0.007	0.293	-0.020	0.006	0.001	0.000	0.003	0.618	-0.008	0.013	0.000	0.000	0.006	0.464	-0.010	0.022	0.000	0.000	0.005	0.514	-0.011	0.022	0.000	0.000
DBP (mmHg)	-0.004	0.561	-0.017	0.009	0.000	0.000	-0.003	0.524	-0.014	0.007	0.000	0.000	-0.005	0.508	-0.021	0.011	0.000	0.000	-0.006	0.481	-0.022	0.010	0.000	0.000
hs-CRP (mg/dL)	-0.038	0.124	-0.087	0.011	0.001	0.001	0.006	0.755	-0.034	0.047	0.000	-0.001	-0.003	0.927	-0.063	0.057	0.000	-0.001	0.000	0.988	-0.060	0.061	0.000	-0.001
IL-6 (pg/mL)	-0.036	0.278	-0.102	0.029	0.001	0.000	-0.082	0.003	-0.136	-0.028	0.005	0.005	-0.075	0.069	-0.156	0.006	0.002	0.001	-0.087	0.036	-0.169	-0.006	0.003	0.002
IL-1 β (pg/mL)	-0.099	0.001	-0.155	-0.043	0.007	0.007	-0.078	0.001	-0.124	-0.032	0.007	0.006	-0.126	< 0.001	-0.195	-0.057	0.008	0.007	-0.135	< 0.001	-0.204	-0.065	0.009	0.008
TNF- α (pg/mL)	-0.061	0.067	-0.126	0.004	0.002	0.001	-0.086	0.002	-0.140	-0.033	0.006	0.006	-0.032	0.430	-0.113	0.048	0.000	0.000	-0.033	0.422	-0.114	0.048	0.000	0.000
IL-10 (pg/mL)	0.094	0.010	0.023	0.166	0.004	0.004	0.048	0.112	-0.011	0.107	0.002	0.001	0.073	0.104	-0.015	0.161	0.002	0.001	0.074	0.101	-0.015	0.163	0.002	0.001
IL-4 (pg/mL)	-0.028	0.591	-0.128	0.073	0.000	0.000	0.015	0.727	-0.068	0.097	0.000	-0.001	-0.076	0.227	-0.200	0.047	0.001	0.000	-0.080	0.210	-0.204	0.045	0.001	0.000
TAC (μ M)	0.158	< 0.001	0.074	0.242	0.008	0.008	0.029	0.414	-0.040	0.098	0.000	0.000	0.093	0.079	-0.011	0.196	0.002	0.001	0.098	0.066	-0.007	0.202	0.002	0.001
MDA (μ M)	-0.018	0.555	-0.079	0.043	0.000	0.000	0.020	0.439	-0.030	0.070	0.000	0.000	0.015	0.692	-0.060	0.090	0.000	-0.001	0.017	0.658	-0.058	0.092	0.000	-0.001

Violaxanthin

Neoxanthin

Astaxanthin

95% CI

95% CI

95% CI

	Violaxanthin		Neoxanthin				Astaxanthin											
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m ²)	-0.008	0.382	-0.026	0.010	0.000	0.000	-0.004	0.670	-0.021	0.014	0.000	-0.001	-0.003	0.154	-0.006	0.001	0.001	0.001
WC (cm)	-0.012	0.326	-0.036	0.012	0.001	0.000	-0.012	0.325	-0.035	0.012	0.001	0.000	-0.003	0.165	-0.008	0.001	0.001	0.001
FBG (mg/dL)	-0.014	0.217	-0.035	0.008	0.001	0.000	-0.018	0.093	-0.039	0.003	0.002	0.001	-0.001	0.635	-0.005	0.003	0.000	0.000
Insulin (mIU/dL)	0.033	0.400	-0.044	0.111	0.000	0.000	0.011	0.773	-0.064	0.087	0.000	-0.001	0.008	0.292	-0.007	0.023	0.001	0.000
HOMA IR	0.020	0.660	-0.067	0.106	0.000	-0.001	-0.007	0.870	-0.092	0.078	0.000	-0.001	0.007	0.413	-0.010	0.024	0.000	0.000
HDL-c (mg/dL)	0.017	0.347	-0.018	0.051	0.001	0.000	0.011	0.516	-0.022	0.045	0.000	0.000	0.002	0.650	-0.005	0.008	0.000	0.000
LDL-c (mg/dL)	0.006	0.762	-0.031	0.043	0.000	-0.001	-0.001	0.935	-0.038	0.035	0.000	-0.001	0.001	0.784	-0.006	0.008	0.000	-0.001
TC (mg/dL)	-0.007	0.583	-0.033	0.018	0.000	0.000	-0.013	0.306	-0.038	0.012	0.001	0.000	0.000	0.883	-0.005	0.005	0.000	-0.001
TG (mg/dL)	-0.053	0.114	-0.119	0.013	0.002	0.001	-0.050	0.126	-0.114	0.014	0.001	0.001	-0.006	0.342	-0.019	0.007	0.001	0.000
SBP (mmHg)	-0.015	0.100	-0.032	0.003	0.002	0.001	-0.014	0.103	-0.031	0.003	0.002	0.001	0.000	0.960	-0.004	0.003	0.000	-0.001
DBP (mmHg)	-0.010	0.236	-0.028	0.007	0.001	0.000	-0.003	0.724	-0.020	0.014	0.000	-0.001	-0.001	0.404	-0.005	0.002	0.000	0.000
hs-CRP (mg/dL)	-0.020	0.551	-0.086	0.046	0.000	0.000	-0.021	0.524	-0.085	0.043	0.000	0.000	-0.003	0.659	-0.016	0.010	0.000	-0.001
IL-6 (pg/mL)	-0.071	0.118	-0.159	0.018	0.002	0.001	-0.080	0.070	-0.166	0.007	0.002	0.001	-0.004	0.632	-0.021	0.013	0.000	0.000
IL-1 β (pg/mL)	-0.120	0.002	-0.195	-0.045	0.006	0.005	-0.123	0.001	-0.197	-0.050	0.007	0.006	-0.013	0.088	-0.028	0.002	0.002	0.001
TNF- α (pg/mL)	-0.015	0.738	-0.103	0.073	0.000	-0.001	-0.013	0.767	-0.099	0.073	0.000	-0.001	0.001	0.867	-0.016	0.019	0.000	-0.001

ARTICLE	Journal Name																	
IL-10 (pg/mL)	0.142	0.004	0.046	0.238	0.005	0.005	0.168	< 0.001	0.074	0.262	0.008	0.007	0.002	0.798	-0.016	0.021	0.000	-0.001
IL-4 (pg/mL)	-0.045	0.515	-0.180	0.090	0.000	0.000	-0.070	0.301	-0.201	0.062	0.001	0.000	-0.016	0.234	-0.042	0.010	0.001	0.000
TAC (μM)	0.252	< 0.001	0.139	0.364	0.012	0.011	0.301	< 0.001	0.191	0.411	0.018	0.017	0.009	0.419	-0.013	0.031	0.000	0.000
MDA (μM)	0.014	0.730	-0.067	0.096	0.000	-0.001	0.027	0.501	-0.052	0.107	0.000	0.000	0.006	0.487	-0.010	0.022	0.000	0.000

	Non-Provitamin A						Total Carotenoids					
			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.
	β	p-value	Lower	Upper			β	p-value	Lower	Upper		
BMI (kg/m ²)	-0.001	0.873	-0.020	0.017	0.000	-0.001	-0.010	0.220	-0.027	0.006	0.001	0.000
WC (cm)	0.005	0.690	-0.019	0.029	0.000	-0.001	-0.014	0.217	-0.035	0.008	0.001	0.000
FBG (mg/dL)	0.006	0.623	-0.017	0.028	0.000	0.000	0.010	0.348	-0.010	0.029	0.001	0.000
Insulin (mIU/mL)	-0.007	0.856	-0.087	0.072	0.000	-0.001	-0.018	0.615	-0.089	0.053	0.000	0.000
HOMA IR	-0.002	0.969	-0.091	0.087	0.000	-0.001	-0.009	0.831	-0.088	0.071	0.000	-0.001
HDL-c (mg/dL)	0.044	0.014	0.009	0.079	0.004	0.003	0.022	0.163	-0.009	0.054	0.001	0.001
LDL-c (mg/dL)	-0.014	0.462	-0.052	0.024	0.000	0.000	-0.016	0.361	-0.050	0.018	0.001	0.000
TC (mg/dL)	-0.012	0.375	-0.038	0.014	0.000	0.000	-0.010	0.399	-0.033	0.013	0.000	0.000
TG (mg/dL)	-0.026	0.451	-0.093	0.041	0.000	0.000	-0.019	0.538	-0.079	0.041	0.000	0.000
SBP (mmHg)	0.003	0.767	-0.015	0.021	0.000	-0.001	-0.003	0.752	-0.019	0.013	0.000	-0.001
DBP (mmHg)	-0.008	0.393	-0.025	0.010	0.000	0.000	-0.007	0.399	-0.023	0.009	0.000	0.000
hs-CRP (mg/dL)	-0.015	0.668	-0.082	0.053	0.000	-0.001	0.010	0.737	-0.050	0.071	0.000	-0.001
IL-6 (pg/mL)	-0.108	0.019	-0.199	-0.018	0.003	0.003	-0.129	0.002	-0.210	-0.049	0.006	0.006
IL-1β (pg/mL)	-0.170	< 0.001	-0.246	-0.093	0.012	0.011	-0.175	< 0.001	-0.244	-0.107	0.015	0.015
TNF-α (pg/mL)	-0.087	0.057	-0.177	0.002	0.002	0.002	-0.103	0.012	-0.183	-0.023	0.004	0.003
IL-10 (pg/mL)	0.106	0.034	0.008	0.205	0.003	0.002	0.146	0.001	0.059	0.234	0.007	0.006
IL-4 (pg/mL)	-0.048	0.499	-0.186	0.091	0.000	0.000	-0.013	0.835	-0.137	0.111	0.000	-0.001
TAC (μM)	0.139	0.019	0.023	0.254	0.003	0.003	0.167	0.002	0.063	0.270	0.006	0.006
MDA (μM)	0.019	0.655	-0.065	0.103	0.000	0.000	0.015	0.690	-0.060	0.090	0.000	-0.001

* Linear regression models were used to assess the unadjusted associations between carotenoids and a selected list of biomarkers relevant to cardiometabolic health, inflammatory status, and oxidative stress. All continuous variables were log-transformed. Carotenoids were adjusted for total energy intake (μg/1000 kcal) prior to log-transformation.

Statistically significant p-values (p < 0.05) are shown in **bold**.

Abbreviations: BMI = body mass index, HOMA IR = homeostatic model assessment of insulin resistance, HDL-c = high-density lipoprotein cholesterol, LDL-c = low-density lipoprotein cholesterol, SBP = systolic blood pressure, DBP = diastolic blood pressure, hs-CRP = high-sensitivity C-reactive protein, IL = interleukin, TNF-α = tumor necrosis factor α, TAC = total antioxidant capacity, MDA = malondialdehyde, WC = waist circumference, FBG = fasting blood glucose, TC = total cholesterol, TG = triglycerides.

Supplementary Table 11: Association between dietary carotenoid intake and biomarkers (anthropometric and serum measurements) based on linear regression – Models 2*.

	α-Carotene						β-Carotene						β-Cryptoxanthin						Provitamin A					
			95% CI						95% CI						95% CI						95% CI			
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m²)	-0.007	0.103	-0.015	0.001	0.02	0.014	-0.008	0.168	-0.020	0.003	0.02	0.014	-0.002	0.795	-0.016	0.012	0.019	0.012	-0.010	0.081	-0.021	0.001	0.02	0.014
WC (cm)	-0.007	0.154	-0.017	0.003	0.254	0.249	-0.012	0.085	-0.026	0.002	0.255	0.250	-0.009	0.297	-0.025	0.008	0.254	0.249	-0.011	0.084	-0.024	0.002	0.255	0.250
FBG (mg/dL)	0.007	0.203	-0.004	0.017	0.005	-0.001	0.006	0.447	-0.009	0.020	0.005	-0.002	0.004	0.650	-0.013	0.021	0.005	-0.002	0.007	0.348	-0.007	0.020	0.005	-0.002
Insulin (mIU/mL)	-0.013	0.475	-0.050	0.023	0.007	0.000	-0.027	0.297	-0.078	0.024	0.007	0.001	-0.008	0.795	-0.069	0.053	0.007	0.000	-0.021	0.396	-0.070	0.028	0.007	0.000
HOMA-IR	-0.007	0.751	-0.048	0.034	0.005	-0.002	-0.022	0.461	-0.079	0.036	0.005	-0.002	-0.004	0.907	-0.072	0.064	0.005	-0.002	-0.014	0.603	-0.069	0.040	0.005	-0.002
HDL-c (mg/dL)	0.000	0.953	-0.016	0.017	0.022	0.015	-0.003	0.783	-0.026	0.019	0.022	0.015	0.013	0.339	-0.014	0.040	0.022	0.016	-0.001	0.901	-0.023	0.020	0.022	0.015
LDL-c (mg/dL)	-0.010	0.265	-0.027	0.008	0.011	0.004	-0.006	0.604	-0.031	0.018	0.01	0.004	-0.005	0.744	-0.034	0.024	0.01	0.003	-0.009	0.462	-0.032	0.015	0.011	0.004
TC (mg/dL)	-0.006	0.316	-0.018	0.006	0.007	0.000	-0.002	0.774	-0.019	0.014	0.006	-0.001	-0.005	0.647	-0.025	0.015	0.006	-0.001	-0.004	0.617	-0.020	0.012	0.006	0.000
TG (mg/dL)	-0.010	0.508	-0.041	0.020	0.012	0.005	-0.005	0.835	-0.048	0.039	0.012	0.005	-0.027	0.300	-0.079	0.024	0.012	0.006	-0.008	0.702	-0.049	0.033	0.012	0.005
SBP (mmHg)	-0.003	0.470	-0.011	0.005	0.016	0.009	-0.004	0.535	-0.015	0.008	0.015	0.009	-0.011	0.104	-0.025	0.002	0.017	0.010	-0.004	0.464	-0.015	0.007	0.016	0.009
DBP (mmHg)	-0.002	0.553	-0.011	0.006	0.02	0.013	-0.004	0.454	-0.016	0.007	0.02	0.013	-0.014	0.041	-0.028	-0.001	0.022	0.016	-0.004	0.438	-0.015	0.007	0.02	0.013
hs-CRP (mg/dL)	0.019	0.214	-0.011	0.050	0.028	0.021	0.023	0.299	-0.020	0.066	0.028	0.021	-0.007	0.785	-0.058	0.044	0.027	0.020	0.024	0.253	-0.017	0.065	0.028	0.021
IL-6 (pg/mL)	-0.067	0.001	-0.108	-0.026	0.028	0.021	-0.077	0.009	-0.135	-0.019	0.026	0.019	-0.098	0.005	-0.167	-0.029	0.027	0.020	-0.081	0.004	-0.136	-0.026	0.027	0.020
IL-1β (pg/mL)	-0.072	0.000	-0.107	-0.037	0.023	0.016	-0.110	0.000	-0.159	-0.060	0.024	0.018	-0.119	0.000	-0.178	-0.061	0.022	0.016	-0.103	0.000	-0.150	-0.056	0.024	0.017
TNF-α (pg/mL)	-0.039	0.066	-0.080	0.003	0.026	0.019	-0.059	0.045	-0.117	-0.001	0.026	0.019	-0.078	0.025	-0.147	-0.010	0.027	0.020	-0.055	0.048	-0.110	0.000	0.026	0.019
IL-10 (pg/mL)	0.055	0.016	0.010	0.100	0.034	0.027	0.090	0.005	0.027	0.153	0.035	0.028	0.078	0.041	0.003	0.152	0.033	0.026	0.083	0.007	0.023	0.142	0.035	0.028
IL-4 (pg/mL)	-0.006	0.845	-0.070	0.057	0.017	0.011	-0.014	0.766	-0.103	0.075	0.018	0.011	-0.119	0.027	-0.224	-0.013	0.02	0.014	-0.013	0.759	-0.098	0.071	0.018	0.011
TAC (μM)	0.073	0.007	0.021	0.126	0.027	0.020	0.091	0.016	0.017	0.165	0.026	0.019	0.088	0.049	0.000	0.177	0.025	0.018	0.091	0.011	0.021	0.162	0.026	0.020
MDA (μM)	0.016	0.405	-0.022	0.055	0.014	0.008	0.005	0.843	-0.048	0.059	0.014	0.007	-0.037	0.256	-0.101	0.027	0.015	0.008	0.008	0.753	-0.043	0.059	0.014	0.007
	Lutein + Zeaxanthin						Lycopene						Phytoene						Phytofluene					
			95% CI						95% CI						95% CI						95% CI			
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m²)	0.002	0.793	-0.012	0.015	0.019	0.012	0.004	0.431	-0.007	0.015	0.019	0.013	-0.008	0.363	-0.024	0.009	0.019	0.013	-0.007	0.424	-0.023	0.010	0.019	0.013
WC (cm)	-0.007	0.360	-0.023	0.008	0.254	0.249	0.013	0.049	0.000	0.026	0.255	0.250	-0.005	0.580	-0.025	0.014	0.254	0.248	-0.007	0.479	-0.026	0.012	0.254	0.249
FBG (mg/dL)	0.001	0.926	-0.016	0.017	0.004	-0.002	0.009	0.204	-0.005	0.022	0.005	-0.001	0.006	0.576	-0.014	0.026	0.005	-0.002	0.006	0.571	-0.014	0.026	0.005	-0.002
Insulin (mIU/mL)	0.000	0.995	-0.059	0.058	0.007	0.000	0.006	0.817	-0.042	0.053	0.007	0.000	-0.027	0.466	-0.099	0.045	0.007	0.000	-0.028	0.445	-0.101	0.044	0.007	0.000
HOMA-IR	0.001	0.986	-0.065	0.066	0.005	-0.002	0.014	0.600	-0.039	0.068	0.005	-0.002	-0.021	0.611	-0.102	0.060	0.005	-0.002	-0.022	0.590	-0.104	0.059	0.005	-0.002
HDL-c (mg/dL)	0.024	0.071	-0.002	0.050	0.024	0.017	0.018	0.101	-0.003	0.039	0.023	0.017	0.036	0.026	0.004	0.068	0.025	0.018	0.035	0.033	0.003	0.067	0.025	0.018

ARTICLE

Journal Name

LDL-c (mg/dL)	0.005	0.712	-0.023	0.033	0.01	0.003	-0.005	0.642	-0.028	0.017	0.01	0.004	-0.018	0.311	-0.052	0.017	0.011	0.004	-0.018	0.312	-0.053	0.017	0.011	0.004
TC (mg/dL)	0.002	0.879	-0.018	0.021	0.006	-0.001	-0.005	0.560	-0.020	0.011	0.006	0.000	-0.010	0.388	-0.034	0.013	0.007	0.000	-0.010	0.395	-0.034	0.014	0.007	0.000
TG (mg/dL)	-0.033	0.195	-0.082	0.017	0.013	0.006	0.007	0.719	-0.033	0.048	0.012	0.005	-0.027	0.377	-0.088	0.033	0.012	0.005	-0.028	0.364	-0.090	0.033	0.012	0.005
SBP (mmHg)	-0.008	0.260	-0.021	0.006	0.016	0.009	0.001	0.900	-0.010	0.011	0.015	0.008	0.006	0.488	-0.010	0.022	0.016	0.009	0.005	0.544	-0.011	0.021	0.015	0.009
DBP (mmHg)	-0.006	0.359	-0.019	0.007	0.02	0.014	-0.006	0.250	-0.017	0.004	0.021	0.014	-0.004	0.655	-0.020	0.012	0.02	0.013	-0.004	0.626	-0.020	0.012	0.02	0.013
hs-CRP (mg/dL)	-0.040	0.111	-0.089	0.009	0.029	0.022	0.001	0.948	-0.039	0.042	0.027	0.020	-0.010	0.735	-0.071	0.050	0.027	0.020	-0.007	0.816	-0.068	0.054	0.027	0.020
IL-6 (pg/mL)	-0.036	0.292	-0.102	0.031	0.023	0.016	-0.091	0.001	-0.145	-0.037	0.029	0.022	-0.076	0.068	-0.157	0.006	0.024	0.017	-0.088	0.035	-0.171	-0.006	0.025	0.018
IL-1 β (pg/mL)	-0.088	0.002	-0.145	-0.032	0.018	0.012	-0.077	0.001	-0.124	-0.031	0.019	0.013	-0.134	0.000	-0.203	-0.064	0.021	0.015	-0.144	0.000	-0.214	-0.074	0.023	0.016
TNF- α (pg/mL)	-0.059	0.080	-0.125	0.007	0.026	0.019	-0.094	0.001	-0.148	-0.040	0.031	0.024	-0.046	0.261	-0.127	0.034	0.024	0.018	-0.048	0.248	-0.130	0.034	0.024	0.018
IL-10 (pg/mL)	0.085	0.020	0.013	0.157	0.033	0.027	0.045	0.130	-0.013	0.104	0.032	0.025	0.079	0.080	-0.009	0.167	0.032	0.025	0.081	0.075	-0.008	0.170	0.032	0.025
IL-4 (pg/mL)	-0.054	0.296	-0.156	0.047	0.018	0.011	0.006	0.889	-0.077	0.089	0.017	0.011	-0.079	0.212	-0.204	0.045	0.018	0.012	-0.082	0.202	-0.208	0.044	0.018	0.012
TAC (μ M)	0.163	0.000	0.079	0.248	0.031	0.024	0.037	0.297	-0.033	0.106	0.023	0.016	0.106	0.046	0.002	0.210	0.025	0.018	0.111	0.038	0.006	0.216	0.025	0.018
MDA (μ M)	-0.017	0.586	-0.079	0.044	0.014	0.007	0.015	0.561	-0.035	0.065	0.014	0.007	0.017	0.652	-0.058	0.093	0.014	0.007	0.020	0.610	-0.056	0.096	0.014	0.007

Violaxanthin

Neoxanthin

Astaxanthin

95% CI

95% CI

95% CI

	Violaxanthin		Neoxanthin				Astaxanthin											
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m ²)	-0.003	0.785	-0.021	0.016	0.019	0.012	0.002	0.787	-0.015	0.020	0.019	0.012	-0.001	0.561	-0.005	0.002	0.019	0.013
WC (cm)	-0.005	0.672	-0.026	0.016	0.254	0.248	-0.005	0.611	-0.026	0.015	0.254	0.248	-0.002	0.427	-0.006	0.002	0.254	0.249
FBG (mg/dL)	-0.011	0.338	-0.033	0.011	0.005	-0.002	-0.015	0.163	-0.037	0.006	0.006	-0.001	-0.001	0.705	-0.005	0.003	0.005	-0.002
Insulin (mIU/mL)	0.020	0.614	-0.059	0.099	0.007	0.000	0.002	0.956	-0.074	0.079	0.007	0.000	0.008	0.289	-0.007	0.024	0.007	0.001
HOMA-IR	0.009	0.835	-0.079	0.098	0.005	-0.002	-0.013	0.764	-0.099	0.073	0.005	-0.002	0.007	0.396	-0.010	0.025	0.005	-0.002
HDL-c (mg/dL)	0.012	0.488	-0.022	0.047	0.022	0.015	0.007	0.664	-0.026	0.041	0.022	0.015	0.001	0.690	-0.005	0.008	0.022	0.015
LDL-c (mg/dL)	0.010	0.587	-0.027	0.048	0.01	0.004	0.003	0.882	-0.034	0.039	0.01	0.003	0.001	0.705	-0.006	0.009	0.01	0.003
TC (mg/dL)	-0.004	0.756	-0.030	0.022	0.006	-0.001	-0.011	0.407	-0.036	0.015	0.007	0.000	-0.001	0.770	-0.006	0.004	0.006	-0.001
TG (mg/dL)	-0.045	0.186	-0.112	0.022	0.013	0.006	-0.045	0.169	-0.110	0.019	0.013	0.006	-0.007	0.318	-0.020	0.006	0.012	0.006
SBP (mmHg)	-0.015	0.094	-0.033	0.003	0.017	0.010	-0.016	0.077	-0.033	0.002	0.017	0.010	0.000	0.807	-0.003	0.004	0.015	0.008
DBP (mmHg)	-0.013	0.139	-0.031	0.004	0.021	0.014	-0.006	0.508	-0.023	0.011	0.02	0.013	-0.002	0.359	-0.005	0.002	0.02	0.014
hs-CRP (mg/dL)	-0.019	0.574	-0.085	0.047	0.027	0.021	-0.012	0.707	-0.077	0.052	0.027	0.020	0.000	0.992	-0.013	0.013	0.027	0.020
IL-6 (pg/mL)	-0.057	0.215	-0.146	0.033	0.023	0.016	-0.063	0.153	-0.150	0.024	0.023	0.016	-0.002	0.818	-0.020	0.015	0.022	0.015
IL-1 β (pg/mL)	-0.116	0.003	-0.193	-0.040	0.018	0.011	-0.113	0.003	-0.188	-0.039	0.018	0.012	-0.008	0.315	-0.023	0.007	0.013	0.007
TNF- α (pg/mL)	-0.006	0.903	-0.094	0.083	0.024	0.017	0.001	0.982	-0.085	0.087	0.024	0.017	0.008	0.375	-0.009	0.025	0.024	0.017
IL-10 (pg/mL)	0.129	0.009	0.032	0.225	0.034	0.028	0.144	0.003	0.050	0.238	0.036	0.029	-0.006	0.556	-0.025	0.013	0.03	0.024
IL-4 (pg/mL)	-0.077	0.269	-0.214	0.060	0.018	0.011	-0.080	0.238	-0.213	0.053	0.018	0.012	-0.017	0.216	-0.044	0.010	0.018	0.012

	0.245	0.000	0.131	0.359	0.033	0.026	0.283	0.000	0.172	0.393	0.038	0.031	0.004	0.724	-0.018	0.026	0.022	0.016
TAC (μM)																		
MDA (μM)	0.000	0.995	-0.083	0.083	0.014	0.007	0.014	0.737	-0.067	0.094	0.014	0.007	0.007	0.401	-0.009	0.023	0.014	0.008
	Non-Provitamin A						Total Carotenoids											
	95% CI						95% CI											
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.						
BMI (kg/m ²)	-0.002	0.841	-0.020	0.017	0.019	0.012	-0.009	0.288	-0.025	0.007	0.019	0.013						
WC (cm)	0.006	0.582	-0.015	0.027	0.254	0.248	-0.007	0.459	-0.026	0.012	0.254	0.249						
FBG (mg/dL)	0.009	0.451	-0.014	0.031	0.005	-0.002	0.012	0.244	-0.008	0.032	0.005	-0.002						
Insulin (mIU/mL)	-0.014	0.725	-0.094	0.066	0.007	0.000	-0.021	0.555	-0.093	0.050	0.007	0.000						
HOMA IR	-0.006	0.901	-0.095	0.084	0.005	-0.002	-0.010	0.816	-0.090	0.071	0.005	-0.002						
HDL-c (mg/dL)	0.040	0.025	0.005	0.076	0.025	0.018	0.016	0.306	-0.015	0.048	0.022	0.016						
LDL-c (mg/dL)	-0.011	0.587	-0.049	0.028	0.01	0.004	-0.011	0.530	-0.045	0.023	0.01	0.004						
TC (mg/dL)	-0.009	0.492	-0.036	0.017	0.007	0.000	-0.007	0.538	-0.031	0.016	0.006	0.000						
TG (mg/dL)	-0.022	0.533	-0.089	0.046	0.012	0.005	-0.012	0.695	-0.072	0.048	0.012	0.005						
SBP (mmHg)	0.001	0.921	-0.017	0.019	0.015	0.008	-0.003	0.674	-0.020	0.013	0.015	0.009						
DBP (mmHg)	-0.009	0.309	-0.027	0.009	0.02	0.014	-0.008	0.349	-0.023	0.008	0.02	0.014						
hs-CRP (mg/dL)	-0.022	0.521	-0.089	0.045	0.027	0.021	0.014	0.653	-0.046	0.074	0.027	0.021						
IL-6 (pg/mL)	-0.112	0.016	-0.202	-0.021	0.025	0.019	-0.120	0.004	-0.200	-0.039	0.027	0.020						
IL-1 β (pg/mL)	-0.170	0.000	-0.247	-0.093	0.024	0.017	-0.177	0.000	-0.245	-0.108	0.028	0.022						
TNF- α (pg/mL)	-0.100	0.030	-0.189	-0.010	0.027	0.020	-0.102	0.013	-0.182	-0.022	0.027	0.021						
IL-10 (pg/mL)	0.107	0.033	0.008	0.205	0.033	0.026	0.140	0.002	0.053	0.227	0.036	0.030						
IL-4 (pg/mL)	-0.062	0.379	-0.201	0.076	0.018	0.011	-0.024	0.703	-0.148	0.100	0.018	0.011						
TAC (μM)	0.152	0.010	0.036	0.268	0.026	0.020	0.163	0.002	0.060	0.267	0.028	0.021						
MDA (μM)	0.018	0.679	-0.066	0.102	0.014	0.007	0.017	0.654	-0.058	0.092	0.014	0.007						

*Multiple linear regression models were used to assess the associations between carotenoids and a selected list of biomarkers relevant to cardiometabolic health, inflammatory status, and oxidative stress. Model 2 was adjusted for the following variables: age (y), sex (male/ female), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension). BMI (kg/m²) was also included as an explanatory variable, in models where it was not the dependent variable. All continuous variables were log-transformed. Carotenoids were adjusted for total energy intake ($\mu\text{g}/1000$ kcal) prior to log-transformation.

Statistically significant p-values ($p < 0.05$) are shown in **bold**.

Abbreviations: BMI = body mass index, HDL-c = high-density lipoprotein cholesterol, LDL-c = low-density lipoprotein cholesterol, SBP = systolic blood pressure, DBP = diastolic blood pressure, hs-CRP = high-sensitivity C-reactive protein, IL = interleukin, TNF- α = tumor necrosis factor α , TAC = total antioxidant capacity, MDA = malondialdehyde, WC = waist circumference, FBG = fasting blood glucose, TC = total cholesterol, TG = triglycerides.

Supplementary Table 12: Association between dietary carotenoid intake and biomarkers in overweight/obese and normal-weight groups Based on BMI*.

	α -Carotene						β -Carotene						β -Cryptoxanthin				Provitamin A							
			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.
	β	p-value	Lower	Upper			β	p-value	Lower	Upper			β	p-value	Lower	Upper			β	p-value	Lower	Upper		
BMI (kg/m²)	0.004	0.110	-0.001	0.008	0.075	0.061	0.001	0.673	-0.005	0.008	0.072	0.058	0.000	0.923	-0.007	0.008	0.072	0.058	0.003	0.312	-0.003	0.009	0.073	0.059
	0.001	0.836	-0.006	0.008	0.059	0.047	0.005	0.377	-0.006	0.015	0.060	0.048	0.006	0.390	-0.007	0.018	0.060	0.048	0.003	0.496	-0.006	0.013	0.060	0.047
WC (cm)	-0.006	0.456	-0.021	0.009	0.018	0.002	-0.009	0.398	-0.030	0.012	0.018	0.002	-0.004	0.752	-0.030	0.022	0.017	0.001	-0.009	0.361	-0.030	0.011	0.018	0.002
	-0.005	0.389	-0.017	0.006	0.304	0.294	-0.007	0.414	-0.024	0.010	0.304	0.294	-0.002	0.846	-0.023	0.019	0.303	0.293	-0.007	0.411	-0.022	0.009	0.304	0.294
FBG (mg/dL)	0.013	0.060	-0.001	0.027	0.013	-0.003	0.008	0.420	-0.011	0.027	0.009	-0.007	0.010	0.396	-0.014	0.035	0.010	-0.006	0.012	0.224	-0.007	0.030	0.011	-0.005
	0.004	0.594	-0.011	0.020	0.025	0.011	0.009	0.449	-0.014	0.032	0.026	0.012	0.002	0.899	-0.026	0.030	0.025	0.011	0.008	0.480	-0.013	0.028	0.026	0.012
Insulin (mIU/mL)	0.037	0.163	-0.015	0.089	0.019	0.003	0.016	0.664	-0.057	0.089	0.017	0.001	0.014	0.767	-0.077	0.104	0.017	0.001	0.033	0.355	-0.037	0.103	0.018	0.002
	-0.039	0.154	-0.092	0.015	0.016	0.002	-0.038	0.348	-0.116	0.041	0.015	0.001	0.027	0.586	-0.070	0.124	0.014	0.000	-0.040	0.282	-0.112	0.033	0.015	0.001
HOMA-IR (%)	0.050	0.089	-0.008	0.109	0.019	0.003	0.024	0.560	-0.057	0.105	0.015	-0.001	0.024	0.639	-0.077	0.125	0.015	-0.001	0.045	0.262	-0.034	0.123	0.016	0.000
	-0.034	0.261	-0.094	0.026	0.011	-0.003	-0.029	0.524	-0.118	0.060	0.010	-0.004	0.029	0.607	-0.081	0.139	0.010	-0.004	-0.032	0.441	-0.114	0.050	0.010	-0.004
HDL-c (mg/dL)	-0.010	0.405	-0.033	0.013	0.020	0.004	-0.029	0.085	-0.061	0.004	0.023	0.007	0.023	0.276	-0.018	0.063	0.021	0.005	-0.023	0.148	-0.055	0.008	0.022	0.006
	0.004	0.707	-0.019	0.027	0.021	0.007	0.012	0.478	-0.022	0.046	0.021	0.007	0.004	0.851	-0.038	0.046	0.020	0.006	0.010	0.550	-0.022	0.041	0.021	0.007
LDL-c (mg/dL)	-0.014	0.293	-0.041	0.012	0.017	0.001	-0.011	0.574	-0.047	0.026	0.016	0.000	0.003	0.910	-0.043	0.048	0.016	0.000	-0.013	0.459	-0.049	0.022	0.016	0.000
	-0.003	0.827	-0.027	0.022	0.028	0.015	0.006	0.727	-0.030	0.042	0.029	0.015	-0.002	0.944	-0.046	0.043	0.028	0.014	0.003	0.856	-0.030	0.036	0.028	0.015
TC (mg/dL)	-0.006	0.491	-0.025	0.012	0.016	0.000	0.001	0.960	-0.025	0.026	0.015	-0.001	-0.015	0.363	-0.046	0.017	0.017	0.001	-0.002	0.879	-0.026	0.023	0.015	0.000
	-0.004	0.643	-0.021	0.013	0.009	-0.005	0.000	0.990	-0.025	0.025	0.008	-0.006	0.010	0.508	-0.020	0.041	0.009	-0.005	-0.002	0.889	-0.024	0.021	0.009	-0.006
TG (mg/dL)	-0.017	0.493	-0.067	0.032	0.010	-0.006	0.005	0.881	-0.064	0.074	0.009	-0.007	-0.067	0.126	-0.152	0.019	0.013	-0.003	-0.005	0.872	-0.072	0.061	0.010	-0.007
	0.000	0.991	-0.041	0.040	0.023	0.009	0.000	0.989	-0.059	0.060	0.023	0.009	0.019	0.615	-0.055	0.093	0.023	0.009	0.001	0.964	-0.054	0.056	0.023	0.009
SBP (mmHg)	-0.007	0.237	-0.018	0.004	0.007	-0.009	-0.013	0.109	-0.028	0.003	0.008	-0.008	-0.024	0.014	-0.043	-0.005	0.013	-0.003	-0.013	0.101	-0.028	0.002	0.009	-0.008
	0.000	0.974	-0.012	0.013	0.033	0.019	0.003	0.725	-0.015	0.022	0.033	0.019	-0.006	0.604	-0.029	0.017	0.033	0.020	0.002	0.798	-0.015	0.019	0.033	0.019
DBP (mmHg)	-0.004	0.543	-0.015	0.008	0.011	-0.005	-0.009	0.295	-0.025	0.008	0.012	-0.004	-0.024	0.020	-0.044	-0.004	0.018	0.002	-0.008	0.314	-0.024	0.008	0.012	-0.004
	0.000	0.955	-0.012	0.011	0.048	0.035	-0.001	0.935	-0.018	0.017	0.048	0.035	-0.012	0.279	-0.033	0.010	0.050	0.036	-0.001	0.940	-0.017	0.015	0.048	0.035
hs-CRP (mg/dL)	0.031	0.221	-0.019	0.081	0.029	0.013	0.051	0.149	-0.018	0.121	0.029	0.014	0.049	0.269	-0.038	0.135	0.028	0.012	0.051	0.134	-0.016	0.118	0.029	0.014
	0.021	0.297	-0.019	0.061	0.026	0.012	0.023	0.445	-0.036	0.082	0.026	0.012	-0.023	0.538	-0.096	0.050	0.025	0.011	0.023	0.405	-0.031	0.077	0.026	0.012
IL-6 (pg/mL)	-0.030	0.392	-0.097	0.038	0.010	-0.006	0.011	0.821	-0.083	0.105	0.009	-0.007	0.020	0.736	-0.097	0.137	0.010	-0.007	-0.006	0.897	-0.097	0.085	0.009	-0.007
	-0.083	0.002	-0.135	-0.031	0.080	0.067	-0.121	0.002	-0.199	-0.043	0.080	0.067	-0.159	0.001	-0.255	-0.063	0.081	0.068	-0.113	0.002	-0.185	-0.042	0.080	0.067
IL-1 β (pg/mL)	-0.055	0.045	-0.109	-0.001	0.035	0.019	-0.071	0.065	-0.145	0.004	0.034	0.018	0.040	0.403	-0.053	0.133	0.030	0.015	-0.073	0.049	-0.145	0.000	0.035	0.019
	-0.056	0.020	-0.103	-0.009	0.104	0.092	-0.079	0.027	-0.149	-0.009	0.104	0.091	-0.165	0.000	-0.251	-0.080	0.114	0.101	-0.074	0.024	-0.138	-0.010	0.104	0.091
TNF-α (pg/mL)	-0.027	0.394	-0.090	0.036	0.036	0.021	-0.034	0.453	-0.122	0.054	0.036	0.020	0.022	0.688	-0.087	0.132	0.035	0.020	-0.034	0.429	-0.119	0.051	0.036	0.020
	-0.048	0.092	-0.104	0.008	0.031	0.017	-0.080	0.059	-0.163	0.003	0.032	0.018	-0.176	0.001	-0.278	-0.073	0.041	0.027	-0.073	0.062	-0.149	0.004	0.032	0.018

IL-10 (pg/mL)	0.041	0.215	-0.024	0.106	0.044	0.029	0.049	0.284	-0.041	0.139	0.044	0.028	0.035	0.544	-0.077	0.147	0.043	0.027	0.048	0.283	-0.039	0.135	0.044	0.028
	0.061	0.065	-0.004	0.125	0.048	0.035	0.112	0.021	0.017	0.208	0.051	0.037	0.099	0.101	-0.019	0.217	0.048	0.034	0.100	0.025	0.013	0.188	0.050	0.037
IL-4 (pg/mL)	0.039	0.461	-0.064	0.141	0.035	0.020	0.037	0.615	-0.107	0.180	0.035	0.019	-0.145	0.109	-0.323	0.033	0.038	0.022	0.041	0.564	-0.098	0.179	0.035	0.019
	-0.021	0.616	-0.102	0.060	0.033	0.019	-0.015	0.811	-0.135	0.106	0.032	0.019	-0.066	0.383	-0.215	0.082	0.033	0.019	-0.020	0.726	-0.130	0.091	0.033	0.019
TAC (μM)	0.063	0.112	-0.015	0.141	0.024	0.008	0.035	0.522	-0.073	0.144	0.021	0.005	0.041	0.548	-0.094	0.176	0.021	0.005	0.053	0.321	-0.052	0.158	0.022	0.006
	0.065	0.092	-0.011	0.141	0.028	0.014	0.112	0.050	0.000	0.224	0.029	0.015	0.084	0.238	-0.055	0.223	0.026	0.012	0.098	0.063	-0.005	0.201	0.028	0.015
MDA (μM)	0.020	0.488	-0.036	0.075	0.034	0.018	0.033	0.407	-0.045	0.110	0.034	0.018	-0.075	0.123	-0.171	0.020	0.036	0.021	0.027	0.475	-0.047	0.101	0.034	0.018
	0.011	0.689	-0.044	0.066	0.034	0.020	-0.021	0.620	-0.102	0.061	0.034	0.021	0.001	0.990	-0.100	0.102	0.034	0.020	-0.011	0.780	-0.086	0.064	0.034	0.020
	Lutein + zeaxanthin						Lycopene						Phytoene				Phytofluene							
	β		95% CI		R ²		β		95% CI		R ²		β		95% CI		R ²		β		95% CI		R ²	
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m ²)	0.004	0.258	-0.003	0.012	0.073	0.060	0.002	0.463	-0.004	0.008	0.073	0.059	0.008	0.150	-0.003	0.018	0.074	0.061	0.007	0.161	-0.003	0.018	0.074	0.061
	0.020	0.001	0.008	0.032	0.072	0.060	0.000	0.984	-0.010	0.010	0.059	0.047	0.021	0.014	0.004	0.039	0.066	0.054	0.021	0.015	0.004	0.038	0.066	0.054
WC (cm)	0.006	0.629	-0.019	0.031	0.017	0.002	0.012	0.246	-0.008	0.033	0.019	0.003	0.024	0.166	-0.010	0.059	0.020	0.004	0.022	0.207	-0.012	0.057	0.019	0.003
	-0.005	0.598	-0.025	0.015	0.303	0.294	0.021	0.009	0.005	0.038	0.309	0.299	-0.009	0.558	-0.037	0.020	0.304	0.294	-0.011	0.454	-0.040	0.018	0.304	0.294
FBG (mg/dL)	-0.001	0.956	-0.024	0.022	0.009	-0.007	0.005	0.641	-0.015	0.024	0.009	-0.007	0.017	0.297	-0.015	0.049	0.010	-0.006	0.019	0.248	-0.013	0.051	0.010	-0.006
	0.010	0.441	-0.016	0.037	0.026	0.012	0.015	0.169	-0.006	0.036	0.027	0.013	0.013	0.499	-0.025	0.051	0.025	0.012	0.011	0.567	-0.027	0.049	0.025	0.011
Insulin (mIU/mL)	0.005	0.912	-0.081	0.091	0.017	0.001	0.045	0.220	-0.027	0.116	0.019	0.003	0.021	0.734	-0.100	0.141	0.017	0.001	0.023	0.709	-0.097	0.143	0.017	0.001
	0.053	0.257	-0.039	0.144	0.015	0.001	0.018	0.631	-0.056	0.092	0.014	0.000	0.044	0.517	-0.089	0.176	0.014	0.000	0.033	0.621	-0.099	0.166	0.014	0.000
HOMA-IR (%)	0.004	0.932	-0.092	0.100	0.015	-0.001	0.049	0.226	-0.030	0.129	0.017	0.001	0.038	0.579	-0.096	0.172	0.015	-0.001	0.042	0.541	-0.092	0.176	0.015	-0.001
	0.063	0.230	-0.040	0.166	0.011	-0.003	0.033	0.437	-0.051	0.117	0.010	-0.004	0.057	0.455	-0.093	0.206	0.010	-0.004	0.044	0.559	-0.105	0.194	0.010	-0.004
HDL-c (mg/dL)	0.024	0.227	-0.015	0.062	0.021	0.005	0.013	0.442	-0.019	0.045	0.020	0.004	0.016	0.557	-0.038	0.070	0.020	0.004	0.014	0.622	-0.040	0.068	0.019	0.004
	0.015	0.458	-0.025	0.054	0.021	0.007	0.028	0.087	-0.004	0.060	0.024	0.010	0.069	0.018	0.012	0.126	0.027	0.013	0.066	0.022	0.009	0.123	0.026	0.013
LDL-c (mg/dL)	-0.002	0.941	-0.045	0.042	0.016	0.000	-0.017	0.349	-0.053	0.019	0.017	0.001	-0.022	0.480	-0.083	0.039	0.016	0.000	-0.020	0.517	-0.081	0.041	0.016	0.000
	0.032	0.133	-0.010	0.074	0.031	0.017	0.008	0.652	-0.026	0.042	0.029	0.015	0.003	0.932	-0.058	0.063	0.028	0.014	0.000	0.988	-0.060	0.061	0.028	0.014
TC (mg/dL)	0.002	0.907	-0.028	0.032	0.015	-0.001	-0.005	0.698	-0.030	0.020	0.016	0.000	-0.010	0.655	-0.052	0.032	0.016	0.000	-0.010	0.633	-0.052	0.032	0.016	0.000
	0.012	0.416	-0.017	0.041	0.009	-0.005	-0.001	0.925	-0.024	0.022	0.008	-0.006	-0.001	0.958	-0.043	0.041	0.008	-0.006	0.000	0.985	-0.042	0.041	0.008	-0.006
TG (mg/dL)	-0.024	0.570	-0.105	0.058	0.010	-0.006	0.037	0.281	-0.030	0.105	0.011	-0.005	0.001	0.983	-0.113	0.115	0.009	-0.007	-0.005	0.932	-0.119	0.109	0.009	-0.007
	-0.025	0.484	-0.094	0.045	0.023	0.009	-0.021	0.473	-0.077	0.036	0.023	0.009	-0.046	0.368	-0.146	0.054	0.024	0.010	-0.041	0.419	-0.142	0.059	0.024	0.010

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SBP (mmHg)	-0.008	0.376	-0.027	0.010	0.006	-0.010	-0.003	0.748	-0.018	0.013	0.005	-0.011	-0.009	0.484	-0.035	0.017	0.006	-0.011	-0.010	0.443	-0.036	0.016	0.006	-0.010
	-0.009	0.401	-0.030	0.012	0.034	0.020	0.003	0.703	-0.014	0.021	0.033	0.020	0.024	0.134	-0.007	0.054	0.036	0.022	0.022	0.162	-0.009	0.053	0.035	0.022
DBP (mmHg)	-0.002	0.839	-0.021	0.017	0.010	-0.006	-0.009	0.248	-0.025	0.007	0.012	-0.004	-0.011	0.415	-0.038	0.016	0.011	-0.005	-0.011	0.417	-0.038	0.016	0.011	-0.005
	-0.009	0.396	-0.029	0.011	0.049	0.035	-0.006	0.452	-0.023	0.010	0.049	0.035	0.001	0.956	-0.028	0.030	0.048	0.035	0.000	0.990	-0.029	0.029	0.048	0.035
hs-CRP (mg/dL)	-0.036	0.396	-0.118	0.047	0.028	0.012	-0.008	0.821	-0.076	0.060	0.027	0.011	0.097	0.097	-0.018	0.212	0.030	0.014	0.104	0.077	-0.011	0.218	0.031	0.015
	-0.027	0.441	-0.095	0.041	0.026	0.012	0.028	0.329	-0.028	0.083	0.026	0.012	-0.042	0.409	-0.141	0.057	0.026	0.012	-0.040	0.429	-0.139	0.059	0.026	0.012
IL-6 (pg/mL)	0.024	0.673	-0.087	0.135	0.010	-0.006	-0.123	0.009	-0.215	-0.031	0.019	0.003	0.126	0.112	-0.029	0.282	0.013	-0.003	0.114	0.152	-0.042	0.269	0.012	-0.004
	-0.041	0.378	-0.131	0.050	0.071	0.057	-0.049	0.189	-0.123	0.024	0.072	0.058	-0.159	0.017	-0.290	-0.029	0.076	0.063	-0.185	0.006	-0.315	-0.054	0.078	0.065
IL-1 β (pg/mL)	-0.005	0.911	-0.094	0.084	0.030	0.014	-0.070	0.064	-0.143	0.004	0.034	0.018	0.017	0.785	-0.107	0.142	0.030	0.014	0.013	0.839	-0.111	0.137	0.030	0.014
	-0.092	0.026	-0.173	-0.011	0.104	0.091	-0.029	0.389	-0.095	0.037	0.099	0.086	-0.110	0.067	-0.227	0.008	0.102	0.089	-0.135	0.024	-0.252	-0.017	0.104	0.091
TNF- α (pg/mL)	0.027	0.606	-0.076	0.131	0.036	0.020	-0.105	0.017	-0.191	-0.019	0.043	0.027	0.015	0.837	-0.130	0.161	0.035	0.020	0.018	0.808	-0.127	0.163	0.035	0.020
	-0.144	0.003	-0.240	-0.048	0.038	0.024	-0.104	0.009	-0.182	-0.025	0.035	0.022	-0.111	0.119	-0.251	0.029	0.031	0.017	-0.116	0.103	-0.256	0.024	0.031	0.017
IL-10 (pg/mL)	0.060	0.271	-0.047	0.166	0.044	0.029	0.005	0.907	-0.083	0.094	0.042	0.027	0.017	0.828	-0.133	0.166	0.043	0.027	0.014	0.857	-0.135	0.163	0.042	0.027
	0.088	0.120	-0.023	0.198	0.047	0.034	0.061	0.186	-0.029	0.150	0.046	0.033	0.106	0.194	-0.054	0.266	0.046	0.033	0.114	0.165	-0.047	0.274	0.047	0.033
IL-4 (pg/mL)	-0.088	0.306	-0.257	0.081	0.036	0.020	-0.074	0.303	-0.214	0.067	0.036	0.020	-0.110	0.361	-0.347	0.127	0.036	0.020	-0.108	0.369	-0.345	0.128	0.036	0.020
	0.049	0.487	-0.090	0.188	0.033	0.019	0.120	0.037	0.007	0.233	0.037	0.024	0.054	0.600	-0.148	0.256	0.033	0.019	0.045	0.664	-0.157	0.246	0.033	0.019
TAC (μ M)	0.114	0.079	-0.013	0.242	0.025	0.009	0.073	0.177	-0.033	0.179	0.023	0.007	0.011	0.904	-0.169	0.191	0.021	0.005	0.010	0.912	-0.169	0.189	0.021	0.005
	0.181	0.006	0.051	0.311	0.033	0.019	-0.047	0.382	-0.153	0.059	0.025	0.011	0.106	0.273	-0.083	0.294	0.026	0.012	0.122	0.203	-0.066	0.311	0.026	0.012
MDA (μ M)	0.007	0.876	-0.084	0.098	0.033	0.017	0.063	0.104	-0.013	0.138	0.036	0.021	0.067	0.301	-0.060	0.195	0.034	0.019	0.067	0.302	-0.060	0.194	0.034	0.019
	-0.055	0.252	-0.150	0.039	0.036	0.022	-0.007	0.857	-0.084	0.070	0.034	0.020	-0.015	0.835	-0.152	0.123	0.034	0.020	-0.008	0.910	-0.145	0.129	0.034	0.020
	Violaxanthin						Neoxanthin						Astaxanthin											
			95% CI						95% CI						95% CI									
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.						
BMI (kg/m ²)	0.004	0.469	-0.006	0.013	0.073	0.059	0.005	0.301	-0.005	0.015	0.073	0.059	0.000	0.923	-0.002	0.002	0.072	0.058						
	0.019	0.017	0.003	0.034	0.066	0.053	0.021	0.006	0.006	0.036	0.068	0.056	0.005	0.001	0.002	0.008	0.072	0.059						
WC (cm)	0.002	0.904	-0.030	0.034	0.017	0.001	-0.001	0.941	-0.034	0.031	0.017	0.001	-0.001	0.800	-0.007	0.005	0.017	0.001						
	0.012	0.352	-0.013	0.038	0.304	0.294	0.010	0.452	-0.015	0.035	0.304	0.294	0.002	0.313	-0.002	0.007	0.304	0.294						
FBG (mg/dL)	0.000	0.976	-0.030	0.031	0.009	-0.007	-0.003	0.837	-0.033	0.027	0.009	-0.007	0.000	0.942	-0.006	0.005	0.009	-0.007						
	-0.015	0.400	-0.048	0.019	0.026	0.012	-0.020	0.228	-0.054	0.013	0.027	0.013	0.001	0.778	-0.006	0.007	0.025	0.011						

Food and Function

Supplementary Tables

Insulin (mIU/mL)	0.046	0.426	-0.067	0.159	0.018	0.002	0.027	0.642	-0.086	0.140	0.017	0.001	-0.006	0.598	-0.027	0.016	0.017	0.001
	0.050	0.401	-0.067	0.168	0.015	0.001	0.041	0.488	-0.074	0.155	0.015	0.000	0.021	0.071	-0.002	0.043	0.018	0.004
HOMA IR (%)	0.046	0.471	-0.080	0.173	0.015	-0.001	0.024	0.713	-0.102	0.150	0.015	-0.001	-0.006	0.624	-0.030	0.018	0.015	-0.001
	0.036	0.597	-0.097	0.168	0.010	-0.004	0.020	0.760	-0.110	0.150	0.009	-0.005	0.021	0.095	-0.004	0.047	0.013	-0.001
HDL-c (mg/dL)	0.011	0.673	-0.040	0.062	0.019	0.003	0.009	0.738	-0.042	0.059	0.019	0.003	0.000	0.919	-0.010	0.009	0.019	0.003
	0.003	0.893	-0.047	0.054	0.020	0.006	-0.007	0.784	-0.057	0.043	0.020	0.006	0.000	0.997	-0.010	0.010	0.020	0.006
LDL-c (mg/dL)	0.014	0.643	-0.044	0.071	0.016	0.000	0.010	0.727	-0.047	0.067	0.016	0.000	0.004	0.447	-0.007	0.015	0.016	0.000
	0.027	0.325	-0.027	0.081	0.030	0.016	0.017	0.531	-0.036	0.069	0.029	0.015	0.002	0.650	-0.008	0.013	0.029	0.015
TC (mg/dL)	-0.011	0.589	-0.050	0.029	0.016	0.000	-0.009	0.640	-0.049	0.030	0.016	0.000	0.000	0.898	-0.008	0.007	0.015	0.000
	0.011	0.563	-0.026	0.048	0.009	-0.005	-0.003	0.885	-0.039	0.034	0.009	-0.006	0.000	0.895	-0.007	0.008	0.009	-0.006
TG (mg/dL)	-0.041	0.452	-0.148	0.066	0.010	-0.006	-0.030	0.579	-0.137	0.077	0.010	-0.006	-0.001	0.952	-0.021	0.020	0.009	-0.007
	-0.031	0.501	-0.120	0.058	0.023	0.009	-0.042	0.342	-0.129	0.045	0.024	0.010	-0.003	0.695	-0.020	0.014	0.023	0.009
SBP (mmHg)	-0.010	0.411	-0.034	0.014	0.006	-0.010	-0.008	0.522	-0.032	0.016	0.005	-0.011	0.000	0.965	-0.004	0.005	0.005	-0.011
	-0.023	0.095	-0.051	0.004	0.036	0.023	-0.026	0.058	-0.053	0.001	0.037	0.024	0.001	0.786	-0.004	0.006	0.033	0.019
DBP (mmHg)	-0.008	0.529	-0.033	0.017	0.011	-0.005	-0.003	0.824	-0.028	0.022	0.010	-0.006	-0.001	0.649	-0.006	0.004	0.011	-0.005
	-0.018	0.166	-0.044	0.008	0.050	0.037	-0.006	0.618	-0.032	0.019	0.049	0.035	-0.001	0.598	-0.006	0.004	0.049	0.035
hs-CRP (mg/dL)	0.013	0.814	-0.095	0.121	0.027	0.011	0.015	0.780	-0.093	0.123	0.027	0.011	0.003	0.806	-0.018	0.023	0.027	0.011
	-0.030	0.507	-0.118	0.058	0.025	0.011	-0.011	0.807	-0.097	0.075	0.025	0.011	-0.003	0.696	-0.020	0.013	0.025	0.011
IL-6 (pg/mL)	0.019	0.799	-0.127	0.165	0.009	-0.007	0.003	0.968	-0.143	0.149	0.009	-0.007	0.022	0.114	-0.005	0.050	0.013	-0.003
	-0.089	0.135	-0.205	0.028	0.072	0.059	-0.074	0.204	-0.187	0.040	0.071	0.058	-0.021	0.062	-0.043	0.001	0.074	0.060
IL-1 β (pg/mL)	-0.030	0.608	-0.147	0.086	0.030	0.014	-0.067	0.261	-0.183	0.050	0.031	0.016	-0.008	0.461	-0.030	0.014	0.030	0.015
	-0.130	0.014	-0.234	-0.026	0.105	0.092	-0.073	0.158	-0.175	0.029	0.101	0.088	-0.009	0.374	-0.029	0.011	0.099	0.087
TNF- α (pg/mL)	0.013	0.852	-0.124	0.150	0.035	0.020	-0.025	0.715	-0.162	0.111	0.035	0.020	0.002	0.850	-0.023	0.028	0.035	0.020
	-0.020	0.758	-0.144	0.105	0.028	0.014	0.028	0.649	-0.093	0.150	0.028	0.014	0.011	0.342	-0.012	0.035	0.029	0.015
IL-10 (pg/mL)	0.100	0.163	-0.040	0.240	0.045	0.029	0.147	0.039	0.008	0.287	0.048	0.033	-0.005	0.715	-0.031	0.022	0.043	0.027
	0.123	0.089	-0.019	0.265	0.048	0.034	0.121	0.089	-0.018	0.260	0.048	0.034	-0.008	0.547	-0.035	0.019	0.045	0.031
IL-4 (pg/mL)	-0.068	0.547	-0.291	0.154	0.035	0.019	-0.066	0.562	-0.288	0.157	0.035	0.019	-0.014	0.511	-0.056	0.028	0.035	0.019
	-0.015	0.872	-0.194	0.164	0.032	0.019	-0.020	0.819	-0.196	0.155	0.032	0.019	-0.011	0.535	-0.045	0.023	0.033	0.019

ARTICLE

Journal Name

TAC (μM)	0.088	0.305	-0.080	0.257	0.022	0.006	0.117	0.173	-0.051	0.285	0.023	0.007	0.011	0.506	-0.021	0.043	0.021	0.005
	0.347	0.000	0.181	0.513	0.044	0.030	0.400	0.000	0.238	0.562	0.051	0.038	-0.001	0.933	-0.033	0.031	0.024	0.010
MDA (μM)	0.037	0.550	-0.083	0.156	0.034	0.018	0.032	0.598	-0.088	0.152	0.033	0.018	0.003	0.812	-0.020	0.025	0.033	0.017
	-0.043	0.485	-0.165	0.078	0.035	0.021	-0.015	0.808	-0.134	0.104	0.034	0.020	0.003	0.820	-0.020	0.026	0.034	0.020
	Non-provitamin A							Total carotenoids										
			95% CI						95% CI									
	β	p-value	Lower	Upper	R^2	R^2 adj.	β	p-value	Lower	Upper	R^2	R^2 adj.						
BMI (kg/m^2)	0.009	0.130	-0.003	0.021	0.075	0.061	0.007	0.169	-0.003	0.016	0.074	0.060						
	0.021	0.031	0.002	0.040	0.064	0.052	0.011	0.152	-0.004	0.027	0.062	0.049						
WC (cm)	0.031	0.133	-0.009	0.070	0.020	0.004	0.000	0.999	-0.032	0.032	0.017	0.001						
	0.024	0.131	-0.007	0.056	0.305	0.295	0.003	0.807	-0.023	0.029	0.303	0.293						
FBG (mg/dL)	0.014	0.459	-0.023	0.051	0.009	-0.007	0.019	0.218	-0.011	0.049	0.011	-0.005						
	0.024	0.266	-0.018	0.066	0.026	0.012	0.021	0.227	-0.013	0.056	0.027	0.013						
Insulin (mIU/mL)	0.061	0.390	-0.078	0.200	0.018	0.002	0.069	0.228	-0.043	0.180	0.019	0.003						
	0.070	0.346	-0.076	0.216	0.015	0.001	-0.016	0.786	-0.136	0.103	0.014	0.000						
HOMA IR (%)	0.075	0.343	-0.080	0.230	0.016	0.000	0.087	0.169	-0.037	0.212	0.017	0.001						
	0.094	0.263	-0.071	0.259	0.011	-0.003	0.005	0.945	-0.130	0.139	0.009	-0.005						
HDL-c (mg/dL)	0.031	0.323	-0.031	0.094	0.020	0.005	-0.015	0.552	-0.065	0.035	0.020	0.004						
	0.072	0.024	0.010	0.135	0.026	0.012	0.039	0.139	-0.013	0.090	0.023	0.009						
LDL-c (mg/dL)	-0.028	0.435	-0.098	0.042	0.016	0.001	-0.026	0.376	-0.082	0.031	0.017	0.001						
	0.028	0.408	-0.039	0.095	0.029	0.015	0.019	0.483	-0.035	0.074	0.029	0.015						
TC (mg/dL)	-0.009	0.715	-0.058	0.040	0.016	0.000	-0.005	0.792	-0.044	0.034	0.016	0.000						
	0.003	0.884	-0.043	0.049	0.009	-0.006	0.000	0.980	-0.037	0.038	0.008	-0.006						
TG (mg/dL)	0.025	0.709	-0.107	0.157	0.010	-0.006	0.002	0.969	-0.104	0.108	0.009	-0.007						
	-0.056	0.318	-0.167	0.054	0.024	0.010	-0.006	0.893	-0.097	0.084	0.023	0.009						
SBP (mmHg)	-0.012	0.426	-0.042	0.018	0.006	-0.010	-0.020	0.100	-0.044	0.004	0.009	-0.008						
	0.011	0.535	-0.023	0.045	0.034	0.020	0.008	0.566	-0.020	0.036	0.034	0.020						
DBP (mmHg)	-0.017	0.290	-0.048	0.014	0.012	-0.004	-0.016	0.206	-0.041	0.009	0.012	-0.004						
	-0.013	0.439	-0.045	0.020	0.049	0.035	-0.003	0.801	-0.030	0.023	0.048	0.035						

hs-CRP (mg/dL)	0.029	0.666	-0.104	0.162	0.027	0.011	0.061	0.264	-0.046	0.168	0.028	0.012
	-0.006	0.907	-0.116	0.103	0.025	0.011	0.035	0.440	-0.054	0.124	0.026	0.012
IL-6 (pg/mL)	0.011	0.907	-0.169	0.191	0.009	-0.007	0.004	0.957	-0.141	0.149	0.009	-0.007
	-0.148	0.044	-0.292	-0.004	0.074	0.061	-0.176	0.003	-0.293	-0.058	0.079	0.066
IL-1 β (pg/mL)	-0.047	0.518	-0.191	0.096	0.030	0.014	-0.120	0.041	-0.235	-0.005	0.035	0.019
	-0.140	0.034	-0.269	-0.010	0.103	0.091	-0.121	0.025	-0.227	-0.015	0.104	0.091
TNF- α (pg/mL)	-0.067	0.436	-0.234	0.101	0.036	0.020	-0.063	0.358	-0.198	0.072	0.036	0.021
	-0.194	0.013	-0.348	-0.040	0.035	0.021	-0.169	0.008	-0.295	-0.044	0.036	0.022
IL-10 (pg/mL)	0.032	0.717	-0.140	0.204	0.043	0.027	0.081	0.248	-0.057	0.220	0.044	0.029
	0.158	0.080	-0.019	0.334	0.048	0.034	0.199	0.007	0.055	0.342	0.053	0.039
IL-4 (pg/mL)	-0.155	0.267	-0.428	0.119	0.036	0.020	0.010	0.928	-0.210	0.230	0.034	0.019
	0.156	0.170	-0.067	0.378	0.035	0.021	0.053	0.564	-0.128	0.235	0.033	0.019
TAC (μ M)	0.099	0.348	-0.108	0.306	0.022	0.006	0.122	0.150	-0.044	0.288	0.023	0.008
	0.131	0.218	-0.077	0.339	0.026	0.012	0.163	0.060	-0.007	0.333	0.029	0.015
MDA (μ M)	0.109	0.146	-0.038	0.256	0.036	0.020	0.086	0.154	-0.032	0.204	0.036	0.020
	-0.032	0.681	-0.183	0.120	0.034	0.020	-0.034	0.594	-0.157	0.090	0.034	0.021

*The First rows for each biomarker show the normal-weight (control) values, and the second rows show the values for overweight/obese (case) participants.

Multiple linear regression models were used to assess the associations between carotenoids and a selected list of biomarkers relevant to cardiometabolic health and inflammatory status. The associations were assessed separately in overweight/obese and normal-weight participants. Groups of overweight/obese and normal weight are determined based on BMI, where normal-weight status is defined as BMI < 25 kg/m² and overweight/obesity is defined as BMI \geq 25 kg/m². The model was adjusted for the following variables: age (y), sex (male/ female), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension) and fruit + vegetable intake. BMI (kg/m²) was also included as an explanatory variable, in models where it was not the dependent variable. All continuous variables were log-transformed. Carotenoids were adjusted for total energy intake (μ g/1000 kcal) prior to log-transformation.

Statistically significant p-values (p < 0.05) are shown in **bold**.

Abbreviations: BMI = body mass index, HDL-c = high-density lipoprotein cholesterol, LDL-c = low-density lipoprotein cholesterol, SBP = systolic blood pressure, DBP = diastolic blood pressure, hs-CRP = high-sensitivity C-reactive protein, IL = interleukin, TNF- α = tumor necrosis factor α , TAC = total antioxidant capacity, MDA = malondialdehyde.

Supplementary Table 13: Association between dietary carotenoid intake and biomarkers in men and women groups*.

	α-Carotene						β-Carotene						β-Cryptoxanthin						Provitamin A							
			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.			95% CI		R ²	R ² adj.		
	β	p-value	Lower	Upper			β	p-value	Lower	Upper			β	p-value	Lower	Upper			β	p-value	Lower	Upper				
BMI (kg/m²)	-0.003	0.597	-0.015	0.009	0.018	0.005	-0.006	0.451	-0.023	0.010	0.018	0.006	-0.007	0.483	-0.028	0.013	0.018	0.005	-0.007	0.391	-0.023	0.009	0.018	0.006		
	-0.007	0.283	-0.019	0.006	0.039	0.027	-0.004	0.695	-0.022	0.015	0.038	0.026	0.017	0.141	-0.006	0.039	0.040	0.028	-0.007	0.392	-0.025	0.010	0.039	0.027		
WC (cm)	-0.003	0.631	-0.017	0.010	0.386	0.378	-0.011	0.250	-0.031	0.008	0.387	0.378	0.007	0.571	-0.017	0.031	0.386	0.378	-0.009	0.351	-0.027	0.010	0.387	0.378		
	-0.011	0.112	-0.024	0.003	0.071	0.058	-0.010	0.326	-0.029	0.010	0.069	0.057	-0.012	0.317	-0.036	0.012	0.069	0.057	-0.013	0.179	-0.031	0.006	0.070	0.058		
FBG (mg/dL)	0.008	0.319	-0.008	0.024	0.013	-0.001	0.010	0.381	-0.012	0.032	0.013	-0.001	0.015	0.296	-0.013	0.042	0.013	-0.001	0.010	0.367	-0.011	0.031	0.013	-0.001		
	0.005	0.521	-0.010	0.019	0.013	0.000	0.002	0.883	-0.019	0.022	0.013	-0.001	-0.004	0.746	-0.030	0.021	0.013	-0.001	0.004	0.723	-0.016	0.023	0.013	-0.001		
Insulin (mIU/mL)	-0.027	0.317	-0.081	0.026	0.016	0.002	-0.038	0.337	-0.114	0.039	0.016	0.002	0.024	0.615	-0.071	0.120	0.015	0.001	-0.036	0.329	-0.108	0.036	0.016	0.002		
	0.021	0.437	-0.031	0.073	0.015	0.001	0.018	0.636	-0.058	0.094	0.014	0.001	0.018	0.697	-0.075	0.112	0.014	0.001	0.027	0.459	-0.044	0.098	0.015	0.001		
HOMA IR (%)	-0.020	0.529	-0.080	0.041	0.009	-0.005	-0.028	0.532	-0.114	0.059	0.009	-0.005	0.039	0.475	-0.068	0.147	0.009	-0.004	-0.026	0.527	-0.108	0.055	0.009	-0.005		
	0.025	0.395	-0.033	0.084	0.015	0.001	0.020	0.647	-0.065	0.105	0.014	0.000	0.014	0.789	-0.090	0.119	0.014	0.000	0.030	0.455	-0.050	0.111	0.015	0.001		
HDL-c (mg/dL)	0.006	0.636	-0.018	0.029	0.018	0.005	0.000	0.990	-0.033	0.033	0.018	0.004	0.017	0.424	-0.024	0.058	0.019	0.005	0.003	0.841	-0.028	0.034	0.018	0.004		
	-0.008	0.532	-0.031	0.016	0.035	0.022	-0.012	0.491	-0.047	0.022	0.035	0.022	0.008	0.701	-0.034	0.051	0.035	0.021	-0.011	0.519	-0.043	0.022	0.035	0.022		
LDL-c (mg/dL)	0.002	0.859	-0.022	0.026	0.014	0.000	0.009	0.606	-0.025	0.043	0.014	0.001	-0.016	0.452	-0.059	0.026	0.015	0.001	0.006	0.699	-0.026	0.039	0.014	0.001		
	-0.018	0.178	-0.045	0.008	0.015	0.002	-0.016	0.424	-0.055	0.023	0.014	0.000	0.018	0.460	-0.030	0.066	0.014	0.000	-0.018	0.323	-0.055	0.018	0.014	0.000		
TC (mg/dL)	0.001	0.912	-0.016	0.018	0.013	-0.001	0.008	0.506	-0.016	0.033	0.013	0.000	0.000	0.991	-0.031	0.031	0.013	-0.001	0.006	0.596	-0.017	0.030	0.013	-0.001		
	-0.011	0.215	-0.029	0.006	0.010	-0.004	-0.008	0.524	-0.034	0.017	0.009	-0.005	-0.001	0.951	-0.033	0.031	0.008	-0.006	-0.010	0.403	-0.034	0.014	0.009	-0.005		
TG (mg/dL)	-0.016	0.477	-0.059	0.028	0.019	0.005	0.018	0.575	-0.044	0.079	0.018	0.005	-0.015	0.694	-0.092	0.061	0.018	0.004	0.006	0.851	-0.052	0.063	0.018	0.004		
	-0.005	0.827	-0.052	0.042	0.012	-0.001	-0.025	0.480	-0.093	0.044	0.013	-0.001	-0.038	0.375	-0.121	0.046	0.013	0.000	-0.020	0.535	-0.084	0.044	0.013	-0.001		
SBP (mmHg)	-0.002	0.807	-0.014	0.011	0.005	-0.009	-0.002	0.808	-0.020	0.016	0.005	-0.009	-0.024	0.038	-0.046	-0.001	0.010	-0.004	-0.003	0.769	-0.020	0.014	0.005	-0.009		
	-0.005	0.429	-0.016	0.007	0.021	0.008	-0.006	0.460	-0.023	0.010	0.021	0.008	-0.006	0.555	-0.026	0.014	0.021	0.008	-0.006	0.412	-0.022	0.009	0.021	0.008		
DBP (mmHg)	0.005	0.430	-0.007	0.017	0.011	-0.003	0.003	0.759	-0.014	0.020	0.010	-0.004	-0.029	0.008	-0.050	-0.007	0.019	0.005	0.003	0.671	-0.013	0.020	0.010	-0.004		
	-0.011	0.072	-0.022	0.001	0.027	0.014	-0.014	0.114	-0.030	0.003	0.026	0.013	-0.008	0.473	-0.028	0.013	0.024	0.010	-0.014	0.084	-0.030	0.002	0.027	0.013		
hs-CRP (mg/dL)	0.035	0.131	-0.010	0.079	0.041	0.028	0.052	0.111	-0.012	0.116	0.042	0.028	0.037	0.366	-0.043	0.116	0.040	0.026	0.051	0.094	-0.009	0.111	0.042	0.029		
	0.022	0.320	-0.022	0.067	0.034	0.020	0.026	0.429	-0.039	0.091	0.033	0.020	-0.014	0.731	-0.093	0.065	0.033	0.019	0.026	0.402	-0.035	0.087	0.033	0.020		
IL-6 (pg/mL)	-0.078	0.011	-0.137	-0.018	0.048	0.035	-0.080	0.065	-0.165	0.005	0.044	0.031	-0.062	0.248	-0.168	0.043	0.042	0.028	-0.086	0.034	-0.166	-0.007	0.045	0.032		

Food and Function

Supplementary Tables

IL-1 β (pg/mL)	-0.041	0.183	-0.101	0.019	0.027	0.013	-0.035	0.434	-0.123	0.053	0.025	0.012	-0.074	0.180	-0.182	0.034	0.027	0.013	-0.043	0.313	-0.126	0.040	0.026	0.012
	-0.072	0.007	-0.123	-0.020	0.032	0.018	-0.111	0.003	-0.185	-0.037	0.034	0.020	-0.070	0.135	-0.162	0.022	0.026	0.012	-0.102	0.004	-0.171	-0.033	0.033	0.020
TNF- α (pg/mL)	-0.036	0.158	-0.086	0.014	0.053	0.040	-0.041	0.275	-0.114	0.032	0.052	0.039	-0.057	0.211	-0.147	0.032	0.052	0.039	-0.045	0.204	-0.113	0.024	0.052	0.039
	-0.054	0.084	-0.115	0.007	0.029	0.016	-0.079	0.075	-0.167	0.008	0.030	0.016	-0.013	0.811	-0.122	0.095	0.026	0.012	-0.074	0.079	-0.156	0.008	0.030	0.016
IL-10 (pg/mL)	-0.023	0.432	-0.082	0.035	0.030	0.017	-0.039	0.373	-0.124	0.046	0.030	0.017	-0.152	0.004	-0.256	-0.048	0.039	0.026	-0.037	0.367	-0.117	0.043	0.030	0.017
	0.049	0.136	-0.015	0.114	0.035	0.021	0.063	0.177	-0.029	0.156	0.034	0.021	0.065	0.265	-0.049	0.179	0.034	0.020	0.061	0.165	-0.025	0.148	0.035	0.021
IL-4 (pg/mL)	0.054	0.105	-0.011	0.120	0.039	0.026	0.108	0.027	0.012	0.204	0.042	0.028	0.062	0.302	-0.056	0.180	0.037	0.024	0.095	0.038	0.005	0.185	0.041	0.028
	0.014	0.767	-0.078	0.106	0.039	0.026	0.037	0.578	-0.094	0.169	0.040	0.026	-0.223	0.007	-0.385	-0.060	0.048	0.035	0.024	0.699	-0.099	0.148	0.039	0.026
TAC (μ M)	-0.012	0.800	-0.104	0.080	0.011	-0.003	-0.041	0.549	-0.175	0.093	0.011	-0.002	0.010	0.904	-0.154	0.174	0.011	-0.003	-0.030	0.643	-0.156	0.096	0.011	-0.002
	0.046	0.229	-0.029	0.121	0.039	0.026	0.066	0.225	-0.041	0.174	0.039	0.026	0.061	0.369	-0.072	0.194	0.038	0.025	0.061	0.232	-0.039	0.162	0.039	0.026
MDA (μ M)	0.097	0.015	0.019	0.175	0.039	0.026	0.103	0.075	-0.010	0.217	0.036	0.022	0.062	0.383	-0.078	0.202	0.033	0.019	0.113	0.038	0.006	0.220	0.037	0.024
	0.003	0.908	-0.055	0.062	0.027	0.013	-0.016	0.706	-0.099	0.067	0.027	0.013	-0.019	0.712	-0.122	0.083	0.027	0.013	-0.012	0.762	-0.090	0.066	0.027	0.013
	0.035	0.203	-0.019	0.088	0.020	0.006	0.040	0.316	-0.038	0.118	0.019	0.005	-0.065	0.183	-0.160	0.031	0.020	0.006	0.040	0.283	-0.033	0.113	0.019	0.005
	Lutein + zeaxanthin				Lycopene				Phytoene				Phytofluene											
			95% CI		R ²				95% CI		R ²		95% CI		R ²				95% CI		R ²			
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.
BMI (kg/m ²)	0.009	0.355	-0.010	0.029	0.018	0.006	0.016	0.059	-0.001	0.033	0.022	0.009	0.007	0.591	-0.020	0.035	0.018	0.005	0.008	0.584	-0.020	0.035	0.018	0.005
	0.006	0.596	-0.015	0.027	0.038	0.026	0.004	0.602	-0.012	0.021	0.038	0.026	0.002	0.921	-0.029	0.032	0.038	0.026	0.004	0.806	-0.027	0.035	0.038	0.026
WC (cm)	-0.003	0.764	-0.026	0.019	0.386	0.780	0.006	0.559	-0.014	0.025	0.386	0.378	-0.018	0.265	-0.050	0.014	0.387	0.378	-0.019	0.234	-0.051	0.012	0.387	0.379
	-0.009	0.456	-0.032	0.014	0.069	0.056	0.026	0.005	0.008	0.044	0.077	0.065	0.015	0.372	-0.018	0.048	0.069	0.056	0.012	0.474	-0.021	0.045	0.069	0.056
FBG (mg/dL)	0.001	0.915	-0.025	0.027	0.012	-0.002	-0.008	0.477	-0.030	0.014	0.012	-0.001	0.006	0.738	-0.030	0.042	0.012	-0.002	0.008	0.679	-0.028	0.044	0.012	-0.002
	-0.002	0.856	-0.026	0.022	0.013	-0.001	0.027	0.006	0.008	0.046	0.022	0.009	0.015	0.404	-0.020	0.050	0.014	0.000	0.013	0.467	-0.022	0.048	0.014	0.000

ARTICLE

Journal Name

Insulin (mIU/mL)	0.048	0.292	-0.041	0.137	0.016	0.003	-0.026	0.506	-0.102	0.051	0.015	0.002	-0.002	0.979	-0.127	0.123	0.015	0.001	-0.005	0.938	-0.129	0.120	0.015	0.001
	0.002	0.961	-0.086	0.090	0.014	0.000	0.071	0.044	0.002	0.141	0.019	0.006	0.063	0.336	-0.065	0.191	0.015	0.002	0.060	0.357	-0.068	0.189	0.015	0.002
HOMA IR (%)	0.049	0.336	-0.051	0.150	0.010	-0.004	-0.034	0.440	-0.120	0.052	0.009	-0.004	0.004	0.950	-0.136	0.145	0.009	-0.005	0.003	0.970	-0.138	0.143	0.009	-0.005
	0.000	1.000	-0.099	0.099	0.014	0.000	0.098	0.014	0.020	0.176	0.021	0.008	0.078	0.288	-0.066	0.222	0.015	0.002	0.073	0.318	-0.071	0.218	0.015	0.001
HDL-c (mg/dL)	0.018	0.370	-0.021	0.056	0.019	0.005	0.018	0.287	-0.015	0.051	0.020	0.006	0.046	0.090	-0.007	0.100	0.022	0.008	0.044	0.103	-0.009	0.098	0.021	0.008
	0.031	0.126	-0.009	0.071	0.038	0.024	0.017	0.284	-0.014	0.049	0.035	0.023	0.048	0.104	-0.010	0.107	0.038	0.025	0.045	0.134	-0.014	0.103	0.037	0.024
LDL-c (mg/dL)	-0.016	0.432	-0.056	0.024	0.015	0.001	-0.031	0.078	-0.065	0.003	0.018	0.004	-0.022	0.439	-0.078	0.034	0.015	0.001	-0.018	0.522	-0.074	0.037	0.015	0.001
	0.039	0.092	-0.006	0.084	0.016	0.003	0.021	0.248	-0.015	0.057	0.015	0.001	-0.005	0.884	-0.071	0.061	0.013	-0.001	-0.009	0.789	-0.075	0.057	0.013	-0.001
TC (mg/dL)	-0.005	0.741	-0.034	0.024	0.013	-0.001	-0.010	0.404	-0.035	0.014	0.014	0.000	-0.005	0.804	-0.045	0.035	0.013	-0.001	-0.002	0.918	-0.042	0.038	0.013	-0.001
	0.015	0.315	-0.015	0.045	0.009	-0.004	0.004	0.730	-0.019	0.028	0.008	-0.005	-0.008	0.722	-0.051	0.036	0.008	-0.005	-0.011	0.624	-0.054	0.033	0.008	-0.005
TG (mg/dL)	0.003	0.933	-0.068	0.075	0.018	0.004	0.000	0.996	-0.061	0.061	0.018	0.004	-0.004	0.933	-0.104	0.096	0.018	0.004	-0.001	0.992	-0.100	0.099	0.018	0.004
	-0.075	0.064	-0.154	0.004	0.017	0.003	0.022	0.488	-0.040	0.085	0.013	-0.001	-0.060	0.312	-0.175	0.056	0.014	0.000	-0.066	0.261	-0.182	0.049	0.014	0.000
SBP (mmHg)	-0.016	0.135	-0.037	0.005	0.008	-0.006	-0.004	0.662	-0.022	0.014	0.005	-0.009	-0.005	0.722	-0.035	0.024	0.005	-0.009	-0.007	0.650	-0.036	0.023	0.005	-0.009
	-0.002	0.820	-0.021	0.017	0.021	0.007	0.004	0.612	-0.011	0.019	0.021	0.007	0.022	0.117	-0.006	0.050	0.024	0.010	0.021	0.131	-0.006	0.049	0.023	0.010
DBP (mmHg)	-0.013	0.197	-0.033	0.007	0.012	-0.002	-0.007	0.417	-0.024	0.010	0.011	-0.003	-0.018	0.205	-0.046	0.010	0.012	-0.002	-0.017	0.228	-0.045	0.011	0.012	-0.002
	-0.001	0.900	-0.021	0.018	0.023	0.010	-0.006	0.427	-0.022	0.009	0.024	0.011	0.007	0.654	-0.022	0.035	0.024	0.010	0.004	0.762	-0.024	0.033	0.023	0.010
hs-CRP (mg/dL)	-0.014	0.721	-0.088	0.061	0.039	0.025	0.032	0.322	-0.031	0.096	0.040	0.026	0.033	0.529	-0.070	0.137	0.039	0.026	0.035	0.501	-0.068	0.139	0.039	0.026
	-0.039	0.315	-0.114	0.037	0.034	0.020	0.004	0.893	-0.055	0.063	0.033	0.019	0.028	0.619	-0.082	0.137	0.033	0.020	0.034	0.544	-0.076	0.144	0.033	0.020
IL-6 (pg/mL)	0.065	0.199	-0.034	0.164	0.042	0.029	-0.058	0.175	-0.143	0.026	0.042	0.029	-0.047	0.507	-0.185	0.092	0.040	0.027	-0.069	0.326	-0.207	0.069	0.041	0.028
	-0.077	0.139	-0.180	0.025	0.027	0.014	-0.086	0.037	-0.166	-0.005	0.030	0.017	0.025	0.747	-0.125	0.174	0.025	0.011	0.008	0.913	-0.141	0.158	0.025	0.011
IL-1 β (pg/mL)	0.014	0.755	-0.073	0.100	0.023	0.009	-0.022	0.557	-0.096	0.052	0.023	0.010	-0.054	0.376	-0.175	0.066	0.024	0.010	-0.075	0.221	-0.195	0.045	0.025	0.011

Food and Function

Supplementary Tables

	-0.088	0.042	-0.173	-0.003	0.055	0.042	-0.046	0.179	-0.113	0.021	0.053	0.040	-0.006	0.930	-0.129	0.118	0.051	0.037	-0.017	0.792	-0.141	0.107	0.051	0.037
TNF-α (pg/mL)	0.002	0.965	-0.099	0.104	0.026	0.012	-0.059	0.184	-0.146	0.028	0.028	0.014	0.011	0.884	-0.132	0.153	0.026	0.012	0.002	0.980	-0.140	0.144	0.026	0.012
	-0.120	0.017	-0.218	-0.021	0.036	0.023	-0.133	0.001	-0.210	-0.055	0.043	0.030	-0.104	0.157	-0.248	0.040	0.032	0.018	-0.099	0.179	-0.243	0.045	0.031	0.018
IL-10 (pg/mL)	0.037	0.498	-0.070	0.144	0.033	0.019	-0.020	0.672	-0.112	0.072	0.032	0.019	0.019	0.799	-0.130	0.169	0.032	0.019	0.029	0.706	-0.121	0.178	0.032	0.019
	0.118	0.038	0.007	0.229	0.041	0.028	0.088	0.051	0.000	0.175	0.040	0.027	0.123	0.138	-0.039	0.285	0.038	0.025	0.117	0.157	-0.045	0.280	0.038	0.025
IL-4 (pg/mL)	-0.026	0.738	-0.179	0.127	0.039	0.026	0.031	0.640	-0.100	0.162	0.039	0.026	-0.138	0.205	-0.351	0.076	0.041	0.028	-0.136	0.210	-0.349	0.077	0.041	0.028
	-0.044	0.581	-0.199	0.112	0.011	-0.002	0.022	0.727	-0.101	0.145	0.011	-0.003	0.028	0.808	-0.199	0.255	0.011	-0.003	0.021	0.856	-0.206	0.248	0.011	-0.003
TAC (μ M)	0.132	0.038	0.007	0.256	0.042	0.029	0.036	0.508	-0.071	0.143	0.038	0.024	0.088	0.319	-0.086	0.263	0.038	0.025	0.098	0.267	-0.075	0.272	0.039	0.025
	0.185	0.006	0.053	0.317	0.041	0.028	-0.011	0.836	-0.116	0.094	0.032	0.019	0.050	0.613	-0.143	0.243	0.032	0.019	0.056	0.573	-0.138	0.249	0.032	0.019
MDA (μ M)	-0.040	0.414	-0.136	0.056	0.028	0.014	0.039	0.350	-0.043	0.122	0.028	0.014	0.078	0.252	-0.056	0.213	0.028	0.015	0.080	0.240	-0.054	0.214	0.029	0.015
	0.007	0.877	-0.083	0.098	0.018	0.004	0.003	0.925	-0.068	0.075	0.018	0.004	-0.010	0.878	-0.142	0.121	0.018	0.004	-0.006	0.924	-0.138	0.126	0.018	0.004
	Violaxanthin						Neoxanthin						Astaxanthin											
			95% CI						95% CI						95% CI									
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.						
BMI (kg/m ²)	-0.002	0.882	-0.028	0.024	0.017	0.005	0.011	0.388	-0.014	0.036	0.018	0.006	-0.003	0.233	-0.008	0.002	0.019	0.007						
	0.004	0.761	-0.023	0.032	0.038	0.026	0.005	0.742	-0.023	0.032	0.038	0.026	0.001	0.837	-0.005	0.006	0.038	0.026						
WC (cm)	-0.003	0.832	-0.033	0.027	0.386	0.377	-0.009	0.526	-0.039	0.020	0.386	0.378	-0.001	0.743	-0.007	0.005	0.386	0.378						
	0.000	0.981	-0.029	0.030	0.068	0.055	0.000	0.994	-0.030	0.029	0.068	0.055	-0.001	0.646	-0.007	0.004	0.069	0.056						
FBG (mg/dL)	-0.019	0.267	-0.053	0.015	0.013	-0.001	-0.029	0.090	-0.062	0.004	0.015	0.002	-0.003	0.336	-0.009	0.003	0.013	-0.001						
	-0.007	0.670	-0.038	0.024	0.013	0.000	-0.007	0.657	-0.038	0.024	0.013	0.000	0.001	0.640	-0.004	0.007	0.013	0.000						
Insulin (mIU/mL)	0.125	0.036	0.008	0.241	0.020	0.007	0.118	0.043	0.004	0.232	0.020	0.006	0.007	0.521	-0.015	0.029	0.015	0.002						
	-0.028	0.630	-0.142	0.086	0.014	0.001	-0.056	0.334	-0.170	0.058	0.015	0.002	0.007	0.540	-0.015	0.028	0.015	0.001						
HOMA IR (%)	0.106	0.116	-0.026	0.237	0.012	-0.002	0.089	0.174	-0.040	0.218	0.011	-0.003	0.004	0.748	-0.021	0.029	0.009	-0.005						

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HDL-c (mg/dL)	-0.035	0.593	-0.163	0.093	0.014	0.001	-0.063	0.332	-0.191	0.065	0.015	0.001	0.008	0.509	-0.016	0.032	0.014	0.001
	0.000	0.996	-0.050	0.050	0.018	0.004	-0.002	0.947	-0.051	0.047	0.018	0.004	-0.002	0.614	-0.012	0.007	0.018	0.005
LDL-c (mg/dL)	0.022	0.406	-0.030	0.074	0.036	0.022	0.013	0.612	-0.039	0.065	0.035	0.022	0.006	0.222	-0.004	0.016	0.036	0.023
	0.006	0.831	-0.046	0.058	0.014	0.000	-0.004	0.892	-0.055	0.047	0.014	0.000	0.003	0.505	-0.006	0.013	0.015	0.001
TC (mg/dL)	0.024	0.420	-0.035	0.083	0.014	0.000	0.018	0.553	-0.041	0.076	0.013	0.000	-0.001	0.860	-0.012	0.010	0.013	-0.001
	0.013	0.510	-0.025	0.050	0.013	-0.001	0.000	0.985	-0.036	0.037	0.013	-0.001	0.002	0.561	-0.005	0.009	0.013	-0.001
TG (mg/dL)	-0.015	0.447	-0.054	0.024	0.009	-0.005	-0.018	0.355	-0.057	0.020	0.009	-0.004	-0.004	0.280	-0.011	0.003	0.010	-0.004
	0.007	0.891	-0.087	0.100	0.018	0.004	-0.027	0.561	-0.119	0.064	0.018	0.005	0.000	0.967	-0.018	0.017	0.018	0.004
SBP (mmHg)	-0.102	0.052	-0.204	0.001	0.017	0.003	-0.071	0.171	-0.174	0.031	0.015	0.001	-0.014	0.170	-0.033	0.006	0.015	0.001
	-0.024	0.090	-0.051	0.004	0.008	-0.005	-0.020	0.153	-0.046	0.007	0.007	-0.007	0.002	0.447	-0.003	0.007	0.006	-0.008
DBP (mmHg)	-0.010	0.426	-0.035	0.015	0.021	0.008	-0.016	0.207	-0.040	0.009	0.023	0.009	-0.001	0.614	-0.006	0.003	0.021	0.007
	-0.014	0.304	-0.040	0.012	0.011	-0.003	-0.001	0.944	-0.026	0.025	0.010	-0.004	-0.001	0.752	-0.006	0.004	0.010	-0.004
hs-CRP (mg/dL)	-0.015	0.231	-0.041	0.010	0.025	0.012	-0.012	0.360	-0.037	0.013	0.024	0.011	-0.003	0.283	-0.007	0.002	0.025	0.011
	0.017	0.730	-0.080	0.114	0.039	0.025	0.007	0.885	-0.088	0.102	0.039	0.025	-0.005	0.576	-0.023	0.013	0.039	0.026
IL-6 (pg/mL)	-0.026	0.600	-0.123	0.071	0.033	0.020	0.000	1.000	-0.097	0.097	0.033	0.019	0.004	0.678	-0.015	0.022	0.033	0.019
	-0.004	0.949	-0.134	0.125	0.040	0.027	0.002	0.979	-0.125	0.129	0.040	0.026	0.006	0.640	-0.019	0.030	0.040	0.027
IL-1 β (pg/mL)	-0.043	0.526	-0.176	0.090	0.025	0.012	-0.056	0.410	-0.188	0.077	0.025	0.012	-0.011	0.389	-0.036	0.014	0.026	0.012
	-0.043	0.455	-0.156	0.070	0.024	0.010	-0.014	0.807	-0.124	0.097	0.023	0.009	-0.002	0.830	-0.024	0.019	0.023	0.009
TNF- α (pg/mL)	-0.090	0.107	-0.200	0.020	0.054	0.041	-0.101	0.072	-0.210	0.009	0.054	0.041	-0.016	0.125	-0.037	0.005	0.053	0.040
	0.077	0.259	-0.056	0.210	0.027	0.014	0.067	0.311	-0.063	0.197	0.027	0.013	0.016	0.217	-0.009	0.041	0.028	0.014
IL-10 (pg/mL)	-0.076	0.243	-0.204	0.052	0.031	0.017	-0.047	0.472	-0.175	0.081	0.030	0.016	0.000	0.983	-0.024	0.024	0.029	0.016
	0.083	0.248	-0.058	0.223	0.034	0.020	0.065	0.355	-0.073	0.202	0.033	0.020	-0.013	0.328	-0.040	0.013	0.033	0.020
	0.148	0.045	0.004	0.392	0.041	0.037	0.308	0.005	0.065	0.352	0.045	0.032	0.002	0.911	-0.036	0.020	0.036	0.032

IL-4 (pg/mL)	-0.098	0.335	-0.298	0.102	0.040	0.027	-0.093	0.349	-0.289	0.102	0.040	0.027	-0.015	0.424	-0.053	0.022	0.040	0.027
	-0.015	0.880	-0.217	0.186	0.011	-0.003	-0.026	0.803	-0.227	0.176	0.011	-0.003	-0.019	0.324	-0.057	0.019	0.012	-0.001
TAC (µM)	0.239	0.004	0.076	0.401	0.047	0.034	0.259	0.001	0.101	0.418	0.050	0.036	0.003	0.831	-0.027	0.034	0.037	0.024
	0.250	0.004	0.080	0.421	0.042	0.029	0.311	0.000	0.141	0.481	0.047	0.034	0.003	0.857	-0.029	0.035	0.032	0.018
MDA (µM)	-0.012	0.853	-0.138	0.114	0.027	0.013	0.009	0.883	-0.114	0.133	0.027	0.013	0.011	0.371	-0.013	0.034	0.028	0.014
	0.032	0.591	-0.085	0.149	0.018	0.004	0.042	0.481	-0.075	0.159	0.018	0.005	0.001	0.917	-0.021	0.023	0.018	0.004
Non-provitamin A										Total carotenoids								
95% CI										95% CI								
	β	p-value	Lower	Upper	R ²	R ² adj.	β	p-value	Lower	Upper	R ²	R ² adj.						
BMI (kg/m ²)	0.021	0.195	-0.011	0.052	0.019	0.007	0.002	0.864	-0.023	0.028	0.017	0.005						
	0.010	0.579	-0.024	0.044	0.038	0.026	-0.004	0.781	-0.032	0.024	0.038	0.026						
WC (cm)	-0.005	0.789	-0.042	0.032	0.386	0.377	-0.010	0.505	-0.040	0.019	0.386	0.378						
	0.039	0.035	0.003	0.076	0.074	0.061	0.001	0.971	-0.030	0.031	0.068	0.055						
FBG (mg/dL)	-0.004	0.848	-0.046	0.038	0.012	-0.002	0.011	0.533	-0.023	0.044	0.012	-0.002						
	0.034	0.085	-0.005	0.072	0.017	0.003	0.021	0.192	-0.011	0.053	0.015	0.001						
Insulin (mIU/mL)	0.013	0.857	-0.130	0.157	0.015	0.001	-0.039	0.506	-0.155	0.077	0.015	0.002						
	0.100	0.165	-0.041	0.242	0.016	0.003	0.086	0.144	-0.030	0.203	0.017	0.003						
HOMA IR (%)	0.009	0.912	-0.153	0.171	0.009	-0.005	-0.029	0.668	-0.159	0.102	0.009	-0.005						
	0.134	0.097	-0.024	0.292	0.017	0.004	0.108	0.105	-0.023	0.238	0.017	0.003						
HDL-c (mg/dL)	0.052	0.097	-0.009	0.114	0.022	0.008	0.026	0.313	-0.024	0.075	0.019	0.006						
	0.058	0.077	-0.006	0.122	0.038	0.025	0.006	0.833	-0.047	0.059	0.035	0.021						
LDL-c (mg/dL)	-0.046	0.158	-0.110	0.018	0.017	0.003	-0.010	0.692	-0.062	0.041	0.014	0.001						
	0.043	0.251	-0.030	0.115	0.015	0.001	0.001	0.978	-0.059	0.061	0.013	-0.001						
TC (mg/dL)	-0.011	0.631	-0.057	0.035	0.013	-0.001	0.002	0.937	-0.036	0.039	0.013	-0.001						
	0.004	0.864	-0.044	0.052	0.008	-0.005	-0.007	0.726	-0.046	0.032	0.008	-0.005						
TG (mg/dL)	-0.001	0.986	-0.116	0.114	0.018	0.004	0.007	0.877	-0.085	0.100	0.018	0.004						
	-0.044	0.502	-0.171	0.084	0.013	-0.001	-0.028	0.602	-0.132	0.077	0.013	-0.001						
SBP (mmHg)	-0.016	0.365	-0.049	0.018	0.006	-0.008	-0.009	0.511	-0.036	0.018	0.005	-0.009						
	0.016	0.318	-0.015	0.046	0.022	0.008	-0.001	0.940	-0.026	0.024	0.021	0.007						
DBP (mmHg)	-0.024	0.140	-0.056	0.008	0.012	-0.001	-0.005	0.728	-0.030	0.021	0.010	-0.004						
	-0.005	0.747	-0.037	0.026	0.023	0.010	-0.017	0.206	-0.042	0.009	0.025	0.012						
hs-CRP (mg/dL)	0.041	0.502	-0.078	0.160	0.039	0.026	0.077	0.115	-0.019	0.174	0.042	0.028						
	0.002	0.975	-0.119	0.123	0.033	0.019	0.029	0.563	-0.070	0.128	0.033	0.020						
IL-6 (pg/mL)	-0.042	0.607	-0.201	0.117	0.040	0.027	-0.105	0.109	-0.233	0.024	0.043	0.030						
	-0.070	0.402	-0.235	0.094	0.025	0.012	-0.065	0.343	-0.200	0.070	0.026	0.012						
IL-1 β (pg/mL)	-0.050	0.477	-0.189	0.088	0.023	0.010	-0.144	0.011	-0.255	-0.032	0.031	0.017						
	-0.082	0.340	-0.218	0.055	0.052	0.020	-0.070	0.160	-0.191	0.022	0.052	0.040						

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TNF- α (pg/mL)	-0.018	0.828	-0.181	0.145	0.026	0.012	-0.099	0.141	-0.231	0.033	0.028	0.015
	-0.232	0.004	-0.390	-0.074	0.039	0.026	-0.135	0.042	-0.265	-0.005	0.034	0.021
IL-10 (pg/mL)	0.020	0.821	-0.152	0.192	0.032	0.019	0.084	0.233	-0.055	0.223	0.034	0.020
	0.195	0.032	0.017	0.374	0.041	0.028	0.215	0.004	0.069	0.361	0.046	0.032
IL-4 (pg/mL)	-0.071	0.568	-0.317	0.174	0.040	0.026	0.025	0.805	-0.173	0.223	0.039	0.026
	0.025	0.844	-0.225	0.275	0.011	-0.003	-0.008	0.938	-0.213	0.197	0.011	-0.003
TAC (μ M)	0.140	0.171	-0.061	0.340	0.039	0.026	0.136	0.100	-0.026	0.297	0.041	0.027
	0.122	0.262	-0.091	0.334	0.033	0.020	0.186	0.037	0.011	0.360	0.037	0.024
MDA (μ M)	0.080	0.312	-0.075	0.234	0.028	0.015	0.016	0.803	-0.109	0.141	0.027	0.013
	-0.001	0.987	-0.146	0.144	0.018	0.004	0.051	0.404	-0.069	0.170	0.018	0.005

* The First rows for each biomarker show the values for male and the second rows for female participants.

Multiple linear regression models were used to assess the associations between carotenoids and a selected list of biomarkers relevant to cardiometabolic health, inflammatory status, and oxidative stress in male and female participants separately. The model was adjusted for the following variables: age (y), marital status (married/ single/ other), education level (having diploma or low literacy/ higher than diploma), smoking status (yes/no), disease history (yes/no for cardiovascular disease, diabetes, and hypertension) and fruit + vegetable intake. BMI (kg/m^2) was also included as an explanatory variable, in models where it was not the dependent variable. All continuous variables were log-transformed. Carotenoids were adjusted for total energy intake ($\mu\text{g}/1000$ kcal) prior to log-transformation.

Statistically significant p-values ($p < 0.05$) are shown in **bold**.

Abbreviations: BMI = body mass index, HDL-c = high-density lipoprotein cholesterol, LDL-c = low-density lipoprotein cholesterol, SBP = systolic blood pressure, DBP = diastolic blood pressure, hs-CRP = high-sensitivity C-reactive protein, IL = interleukin, TNF- α = tumor necrosis factor α , TAC = total antioxidant capacity, MDA = malondialdehyde.