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Supplementary data

Quantitative associations and combined effect on blood lipids of co-exposure to serum liquid crystal monomers: a preliminary study

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S1. Serum LCMs measured

20 μL of mixed internal standard solution (BPh-d10, PCB82 and PCB141, PCB198, 500 ng/mL) was added to the serum sample, and then 360 μL of methanol was added and mixed, and the supernatant was extracted by centrifugation at 4500 rpm/min to precipitate the proteins, and the supernatant was added with the solvent mixture (HEX: ACE, 3:1). The supernatant was extracted by centrifugation at 4500 rpm/min after sonication (100 Hz, 10 min), and the extraction procedure was repeated for three times. The samples were purified using a Si SPE column, and the analytes were first pre-eluted with 3 mL of dichloromethane/acetone (v/v, 1/1) and 3 mL of n-hexane, then eluted with 8 mL of n-hexane/ dichloromethane (v/v, 1/1), and finally, the eluate was then concentrated to near dryness under a gentle stream of ultra-pure N2 and reconstituted with 80 μL ISO and 20 μL Recovery standards (500 ng/mL), transferred to a glass vial, and stored at –20 °C until instrumental analysis.

Quantification of the 57 target LCMs was performed using Gas chromatography-triple quadrupole tandem mass spectrometry in the electron impact (EI) ionization mode (GC–MS/MS, Agilent Technologies, USA), and analysis was performed in the multiple reaction monitoring (MRM) mode. A DB-5MS column (30 m × 0.25 mm × 0.25 μm, Agilent Technologies, Santa Clara, CA, USA) was used for separation. The injection volume was 1 μL, with high-purity helium as the carrier gas and a constant flow rate of 1 mL/min. The settings of the temperature program refer to those in a previous study [1]: the temperature was maintained at 100 °C for 1 min, raised to 200 °C at 10 °C /min, to 240 °C at 3 °C/min for 1 min, and lastly to 300 °C for 16 min at 15 °C/min.

1. Supplementary tables

Table S1. Basic information and MS parameters for target compounds.

Full name	Abbreviation	CAS Nos	Formula	MW[a]	MQ[b]	CE[c]	MC[d]	CE[c]	RT[e]
Target compounds									
1,1'-Bicyclohexyl,4-ethenyl-4'-propyl-, trans,trans	PVB (3VbcH)[f]	116020-44-1	$C_{17}H_{30}$	234.42	205.1/81.0	10	234.1/109.0	10	10.930
trans, trans-4-(4-Methylphenyl)-4'-vinylbicyclohexyl	EBMB (MePVbcH)[f]	155041-85-3	$C_{21}H_{30}$	282.463	118.1/117.1	10	282.1/157.1	10	19.663
trans-4-ethyl-4'-(4-propylcyclohexyl)-1,1'-biphenyl	EPB (3cH2B)[f]	84540-37-4	$C_{23}H_{30}$	306.484	306.1/193.1	20	306.1/221.1	10	26.304
(trans,trans)-4-Butyl-4'-ethenyl-1,1'-bicyclohexyl	BVBC	153429-47-1	$C_{18}H_{32}$	248.447	219.1/81.0	15	248.2/109.1	10	12.181
1-[(trans,trans)-4'-(3-Buten-1-yl)[1,1'-bicyclohexyl]-4-yl]-4-methyl-benzene	MPhBB	129738-42-7	$C_{23}H_{34}$	310.516	118.1/117.1	10	310.2/118.1	15	24.386
(trans,trans)-4-(1E)-1-Propen-1-yl-4'-propyl-1,1'-bicyclohexyl	PPB (Pe3bcH)[f]	279246-65-0	$C_{18}H_{32}$	248.447	248.2/123.1	10	205.1/81.0	10	12.341
4-(4-Methylphenyl)-4'-propyl-1,1'-bi (cyclohexyl	MPCB	84656-75-7	$C_{22}H_{34}$	298.505	118.0/117.1	10	298.2/118.1	10	22.085
4-Methyl-4'-pentylbiphenyl	MPB (5MeB)[f]	64835-63-8	$C_{18}H_{22}$	238.367	181.1/165.0	20	238.1/181.1	15	14.327
trans,trans-4-Propyl-4'-methoxybicyclohexyl	MOPB (MeO3bcH)[f]	97398-80-6	$C_{16}H_{30}O$	238.409	163.1/81.0	10	206.2/123.1	10	11.512
4-cyano-4'-ethoxybiphenyl	2OCB	58743-78-5	$C_{15}H_{13}NO$	223.27	195.0/166.0	15	223.1/195.1	10	15.320
4'-Propoxy-4-biphenylcarbonitrile	3OCB	52709-86-1	$C_{16}H_{15}NO$	237.296	237.1/195.1	10	195.0/166.0	15	17.065
trans-4-[4-[1-(E)-propenyl]cyclohexyl] benzonitrile	3eCHB	96184-40-6	$C_{16}H_{19}N$	225.329	168.0/153.0	20	225.1/168.1	10	13.710
4-Butyl-4'-cyanobiphenyl	4CB	52709-83-8	$C_{17}H_{17}N$	235.324	235.1/192.0	15	192.0/165.0	20	16.499
4-(4-Propylcyclohexyl) benzonitrile	3CHB	61203-99-4	$C_{16}H_{21}N$	227.345	129.1/102.0	15	227.1/129.0	15	13.627
4-(trans-4-Butylcyclohexyl) benzonitrile	4CHB	61204-00-0	$C_{17}H_{23}N$	241.371	129.0/102.1	15	241.1/129.0	15	15.314
4-(4-Ethylcyclohexyl) benzonitrile	EtCBN	73592-81-1	$C_{15}H_{19}N$	213.318	213.1/129.0	20	213.1/103.0	20	12.260
4'-(Octyloxy)-4-biphenylcarbonitrile	8OCB	52364-73-5	$C_{21}H_{25}NO$	307.429	195.1/166.0	20	307.2/195.1	10	27.749
4''-Ethyl-2'-fluoro-4-propyl-1,1':4',1''-terphenyl	EFPT (2F3T)[f]	95759-44-7	$C_{23}H_{23}F$	318.427	318.1/289.1	20	289.1/274.1	25	27.323
1,2,3-Trifluoro-5-[(trans,trans)-4'-propyl[1,1'-bicyclohexyl]-4-yl]benzene	TPrCB	131819-23-3	$C_{21}H_{29}F_3$	338.45	158.1/132.0	20	338.1/203.0	5	19.553
4'-[(trans, trans)-4'-Ethyl[1,1'-bicyclohexyl]-4-yl]-3,4,5-trifluoro-1,1'-biphenyl	EBCTFB	137529-40-9	$C_{26}H_{31}F_3$	400.52	399.8/233.7	10	399.8/399.8	10	30.222
4-(3,4-Difluoro-phenyl)-4'-propyl-bicyclohexyl	DPrCB	82832-57-3	$C_{21}H_{30}F_2$	320.46	140.1/114.1	25	320.1/140.1	20	20.063
4-[2-(3,4-Difluorophenyl) ethyl]-4'-propyl-1,1'-bi(cyclohexyl)	DFEPBC	107215-66-7	$C_{23}H_{34}F_2$	348.513	348.2/128.0	5	348.2/347.8	5	24.332
trans, trans-4'-Propyl-4-(4-trifluoromethoxyphenyl) bicyclohexyl	PCTB (tFMeO-3bcHP)[f]	133937-72-1	$C_{22}H_{31}F_3O$	368.476	188.1/119.1	15	368.1/188.1	15	19.465
3,4-Difluoro-4'-(trans-4-propylcyclohexyl) biphenyl	DPrB	85312-59-0	$C_{21}H_{24}F_2$	314.412	314.1/216.1	10	216.1/201.1	25	21.086
1-[4-(4-butylcyclohexyl)-cyclohexyl]-4-ethoxy-2,3-difluoro-benzene	BCEDB (2OdFP4bcH)[f]	473257-15-7	$C_{24}H_{36}F_2O$	378.539	184.1/156.0	5	378.0/184.1	5	28.254
trans-1-Ethoxy-2,3-difluoro-4-(4-propyl-cyclohexyl)-benzene	EDPrB (2O3cHdFP)[f]	174350-05-1	$C_{17}H_{24}F_2O$	282.369	282.1/169.1	25	156.0/127.1	25	13.178

Table S1. *Cont.*

Full name	Abbreviation	CAS Nos	Formula	MW[a]	MQ[b]	CE[c]	MC[d]	CE[c]	RT[e]
Target compounds									
1,2,3-trifluoro-5-[2-fluoro-4-(4-propylphenyl) phenyl] benzene	TePT	205806-87-7	$C_{21}H_{16}F_4$	344.345	344.1/315.1	25	315.1/275.0	30	21.261
trans, trans-4-(3,4-Difluorophenyl)-4'-pentylbicyclohexyl	DPeCB	118164-51-5	$C_{23}H_{34}F_2$	348.513	140.0/114.1	25	348.1/140.1	10	24.861
trans, trans-4''-(4-ethoxy-2,3-difluoro-phenyl)-4-propyl-bicyclohexyl	EDPBB (2OdFP3bcH)[f]	123560-48-5	$C_{23}H_{34}F_2O$	364.512	184.1/156.0	5	364.1/184.1	5	26.915
4'-(trans-4-Propylcyclohexyl)-2,3-difluoro-4-ethoxy-1,1'-biphenyl	EDPB (2O3cHdFB)[f]	189750-98-9	$C_{23}H_{28}F_2O$	358.465	358.1/245.1	20	358.1/330.2	5	27.719
1,2,3-Trifluoro-5-[trans-4-[2-(trans-4-propylcyclohexyl) ethyl] cyclohexyl] benzene	TPrECB	131819-24-4	$C_{23}H_{33}F_3$	366.503	366.1/213.1	5	213.1/145.1	25	24.254
4'-(trans-4-Propylcyclohexyl)-3,4,5-trifluorobiphenyl	TrPrB	132123-39-8	$C_{21}H_{23}F_3$	332.403	332.1/247.1	20	234.0/233.1	20	20.313
3,4-Difluoro-4'- [(trans, trans)-4'-pentyl[1,1'-bicyclohexyl]-4-yl]biphenyl	DPeBB (5bcHdFB)[f]	136609-96-6	$C_{29}H_{38}F_2$	424.609	424.1/216.1	15	216.1/201.0	20	34.523
trans, trans-4'-(4'-Pentyl-bicyclohexyl-4-yl) -3,4,5-trifluorobiphenyl	TPeBB	137529-43-2	$C_{29}H_{37}F_3$	442.599	221.1/201.1	20	442.3/234.1	20	33.827
trans, trans-3,4,5-Trifluoro-4'-(4'-propylbicyclohexyl-4-yl) biphenyl	TPrBB	137529-41-0	$C_{27}H_{33}F_3$	414.546	221.1/201.1	25	414.1/234.1	20	31.191
3,4-Difluoro-4'-[(trans, trans)-4'-propyl[1,1'-bicyclohexyl] -4-yl]biphenyl	DPrBB (3bcHdFB)[f]	119990-81-7	$C_{27}H_{34}F_2$	396.556	396.2/216.2	15	216.2/201.0	20	31.662
trans, trans-4-(3,4-Difluorophenyl)-4'-butylbicyclohexyl	DBCB	82832-58-4	$C_{22}H_{32}F_2$	334.486	334.1/83.2	15	127.0/101.0	25	22.403
1,2-Difluoro-4-[trans-4-(trans-4-ethylcyclohexyl) cyclohexyl] benzene	DECB	118164-50-4	$C_{20}H_{28}F_2$	306.433	140.1/138.9	15	306.1/140.1	10	18.017
trans, trans-4-(4-Fluorophenyl)-4'-propylbicyclohexyl	FPCB	82832-27-7	$C_{21}H_{31}F$	302.469	122.1/121.1	15	302.1/122.1	15	19.879
trans, trans-4-(3,4-Difluorophenyl)-4'-vinylbicyclohexyl	DFPVBC	142400-92-8	$C_{20}H_{26}F_2$	304.417	179.0/178.8	5	304.1/303.8	5	17.847
trans-4-(4-Propylcyclohexyl)-4'-fluorobiphenyl	FPB	87260-24-0	$C_{21}H_{25}F$	296.422	211.1/196	15	296.1/211.1	10	21.158
1-[4-(4-ethylcyclohexyl) cyclohexyl]-4-(trifluoromethoxy)benzene	ECTB	135734-59-7	$C_{21}H_{29}F_3O$	354.45	188.0/91.0	30	354.1/188.1	15	17.502
2-Fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl) biphenyl	FPePrB	106349-49-9	$C_{32}H_{45}F$	448.698	448.2/97.0	25	448.3/350.2	30	40.854
1-ethoxy-2,3-difluoro-4-(4-pentylcyclohexyl) benzene	EDPeB	124729-02-8	$C_{19}H_{28}F_2O$	310.422	184.0/156.0	10	310.0/197.0	15	16.540
3,4-Difluoro-4'-(trans-4-pentylcyclohexyl) biphenyl	DPeB	134412-17-2	$C_{23}H_{28}F_2$	342.465	216.1/201.1	25	342.0/216.1	15	25.950
3,4-Difluoro-4'-(trans-4-ethylcyclohexyl) biphenyl	DFECB	134412-18-3	$C_{20}H_{22}F_2$	300.385	300.1/228.8	15	300.1/215.8	15	18.983
3,4,5-Trifluoro-1-[trans-4'-(trans-4''-pentylcyclohexyl)-cyclohexyl]-benzene	TPeCB	137644-54-3	$C_{23}H_{33}F_3$	366.503	145.1/125.0	25	366.0/231.2	5	24.259
4-[(trans, trans)-4'-(3-Buten-1-yl)[1,1'-bicyclohexyl]-4-yl]-1,2-difluoro-benzene	BBDB	155266-68-5	$C_{22}H_{30}F_2$	332.47	332.2/179.1	20	179.1/164.0	15	22.294

Table S1. *Cont.*

Full name	Abbreviation	CAS Nos	Formula	MW[a]	MQ[b]	CE[c]	MC[d]	CE[c]	RT[e]
Target compounds									
2',3,4,5-Tetrafluoro-4'-(trans-4-propylcyclohexyl) biphenyl	TePrB	173837-35-9	$C_{21}H_{22}F_4$	350.393	239/219	25	350.1/251.9	15	19.610
[Trans(trans)]-1-(4'-ethyl[1,1'-bicyclohexyl]-4-yl)-2,3-difluoro-4-methylbenzene	EBDMB	174350-08-4	$C_{21}H_{30}F_2$	320.46	154.1/153.1	15	320.2/154.1	20	20.299
1-Butoxy-2,3-difluoro-4-(trans-4-propylcyclohexyl) benzene	BDPrB	208709-55-1	$C_{19}H_{28}F_2O$	310.422	310.1/254.1	5	254.1/156.0	5	16.388
2'-Fluoro-4-Pentyl-4''-Propyl-1,1':4',1''-Terphenyl	PFPT	95759-51-6	$C_{26}H_{29}F$	360.507	303.1/274.0	25	360.1/303.1	15	30.251
4-[Difluoro(3,4,5-trifluorophenoxy)methyl]-3,5-difluoro-4'-propyl-biphenyl	DTMDPB (tFPO-CF2-Df3b)[f]	303186-20-1	$C_{22}H_{15}F_7O$	428.343	281.1/252.1	25	252.0/183.0	25	20.717
1-[4-(4-butylcyclohexyl)cyclohexyl]-4-ethoxy-2,3-difluoro-benzene	BCEDB (2OdFP4bcH)[f]	473257-15-7	$C_{24}H_{36}F_2O$	378.539	184.1/156.0	5	378.0/184.1	5	28.254
4-[Difluoro(3,4,5-trifluorophenoxy)methyl]-3,5-difluoro-4'-ethyl-biphenyl	DTMDEB	303186-19-8	$C_{21}H_{13}F_7O$	414.316	267.0/252.0	25	252.0/183.0	25	18.830
2,3-Difluoro-1-methoxy-4-[(trans-4-propylcyclohexyl)methoxy]benzene	DMPMB	1373116-00-7	$C_{17}H_{24}F_2O_2$	298.368	160.0/145.0	10	298.1/160.0	5	15.372
3,4,5-Trifluoro-4'-(trans-4-pentylcyclohexyl)biphenyl	TrPeB	137019-95-5	$C_{23}H_{27}F_3$	360.456	247.1/232.1	20	234.1/219.1	25	25.078
1,2-Difluoro-4-[trans-4-[2-(trans-4-propylcyclohexyl)ethyl]cyclohexyl]-benzene	DPrECB	117943-37-0	$C_{23}H_{34}F_2$	348.513	140.1/114.1	25	348.1/140.1	10	24.235
Internal standards, ISs									
D10-Biphenyl	BPh-d10	1486-01-7	$C_{12}D_{10}$	164.27	164.1/162.2	20	162.1/160.2	20	6.492
2,2',3,3',4-Pentachlorobiphenyl	PCB82	52663-62-4	$C_{12}H_5Cl_5$	326.4331	326.0/256.0	25	328.0/256.0	25	17.359
2,2',3,4,5,5'-Hexachlorobiphenyl	PCB141	52712-04-6	$C_{12}H_4Cl_6$	360.88	362.0/292.0	25	360.0/292.0	25	19.401
2,2',3,3',4,5,5',6-Octachlorobiphenyl	PCB198	68194-17-2	$C_{12}H_2Cl_8$	429.77	428.0/358.0	30	430.0/358.0	30	24.490
Recovery standards, RSs									
2,3,6-Trichlorobiphenyl	PCB24	55702-45-9	$C_{12}H_7Cl_3$	257.54298	256.0/186.0	20	258.0/186.0	20	11.402

MW[a]: molecular weight; MQ[b]: MS quantitation; CE[c]: Collision energy (eV); MC[d]: MS confirmation; RT[e]: Retention time (min); [f]: Compound aliases.

Table S2. The recoveries, LOD, and LOQ of 57 LCMs standards.

	Recoveries (%)		LOQ (ng/mL)	LOD (ng/mL)
	Mean	RSD		
PVB	101	8.94	2.33E-02	7.75E-03
MOPB	78.2	1.03	8.60E-03	2.86E-03
BVBC	107	8.37	6.25E-02	2.08E-02
PPB	75	4.36	1.00E-03	3.40E-04
MPB	71.7	2.20	1.00E-04	1.78E-05
EBMB	65.3	1.86	0.131	0.0437
MPCB	86	5.72	2.667	0.889
MPhBB	95	9.34	7.27E-02	2.42E-02
EPB	96.3	3.93	1.00E-04	3.12E-05
EtCBN	85.0	4.06	6.00E-04	1.84E-04
3CHB	99.0	1.07	4.39E-02	1.46E-02
3eCHB	96.8	0.79	2.96E-02	9.86E-03
4CHB	88.6	7.66	1.96E-02	6.55E-03
2OCB	84.6	6.27	0.977	0.326
4CB	85.2	1.40	2.00E-04	7.05E-05
3OCB	104	3.31	1.00E-03	3.49E-04
8OCB	115	1.74	5.20E-03	1.73E-03
EDPrB	75.7	5.48	3.01E-05	1.00E-05
DMPMB	94.7	1.32	7.35E-03	2.45E-03
BDPrB	85.2	5.22	3.27E-05	1.09E-05
EDPeB	71.2	2.71	1.08E-02	3.60E-03
ECTB	82.5	5.86	1.43E-02	4.76E-03
DFPVBC	92.6	2.77	2.25E-01	7.49E-02
DECB	91.4	1.97	4.15E-02	1.38E-02
DTMDEB	97.9	2.42	3.19E-04	1.06E-04
DFECB	93.2	5.79	2.73E-05	9.10E-06
PCTB	106	6.21	7.33E-03	2.44E-03
TPrCB	88.5	7.25	5.79E-03	1.93E-03
TePrB	81.5	2.78	4.26E-04	1.42E-04
FPCB	87.4	5.96	3.14E-02	1.05E-02
DPrCB	92.7	2.65	5.95E-03	1.98E-03
EBDMB	87.5	3.12	1.07E-01	3.57E-02
TrPrB	93.1	7.57	6.28E-04	2.09E-04
DTMDPB	104	2.35	1.35E-04	4.50E-05
DPrB	97.7	1.39	5.76E-04	1.92E-04
FPB	103	3.63	8.64E-03	2.88E-03
TePT	117	1.66	3.88E-04	1.29E-04
BBDB	102	9.34	1.64E-03	5.45E-04
DBCB	104	4.97	1.02E-03	3.41E-04
TPrECB	99.0	4.98	1.83E-02	6.10E-03
DPrECB	104	1.24	1.43E-03	4.78E-04
TPeCB	99.1	10.8	1.30E-03	4.32E-04
DFEPBC	109	2.46	9.60E-02	3.20E-02
DPeCB	93.5	6.76	1.45E-02	4.83E-03
TrPeB	97.8	3.34	4.51E-02	1.50E-02
DPeB	104	2.99	1.84E-03	6.13E-04
EDPBB	111	1.80	4.12E-03	1.37E-03
EFPT	104	1.41	1.04E-04	3.48E-05
EDPB	101	8.51	7.80E-05	2.60E-05
BCEDB	101	1.62	6.51E-03	2.17E-03
EBCTFB	116	0.36	2.12E-03	7.05E-04
PFPT	103	1.22	1.86E-03	6.19E-04
TPrBB	103	3.01	2.16E-03	7.20E-04
DPrBB	110	4.26	4.75E-03	1.58E-03
TPeBB	94.1	7.94	1.61E-03	5.36E-04
DPeBB	109	5.29	9.02E-04	3.01E-04
FPePrB	105	3.97	8.68E-02	2.89E-02

Table S3. Basic characteristics of Qingyuan and Guangzhou population.

	All population (n = 78)	Qingyuan (n = 43)	Guangzhou (n = 35)	*P* value
Age (years), Mean ± SD	41 ± 13.9	49 ± 11.0	32 ± 11.0	< 0.001 [c]
BMI (kg/m^2), Median (P_{25}, P_{75})	22.4 (20.6, 24.2)	22.7 (20.8, 25.5)	21.4 (20.0, 24.1)	0.052 [b]
Male, n (%)	30.0 (38.5%)	19 (44.2%)	20.0 (57.1%)	0.255 [c]
Smokers, n (%)	20.0 (25.6%)	6 (14.0%)	14.0 (40.0%)	0.009 [c]
Packyears of smoking, Median (P_{25}, P_{75})	5.25 (1.81, 10)	14.5 (8.25, 21.9)	4.28 (1.48, 6.99)	0.033 [b]
Alcohol drinkers, n (%)	34.0 (43.6%)	19.0 (44.2%)	15.0 (42.9%)	0.906 [c]
Years of alcohol drinking, Median (P_{25}, P_{75})	13.0 (10.0, 20.8)	14.5 (12.0, 20.5)	10.0 (3.0, 24.0)	0.535 [b]
Income per year, n (%) [d]				
<= 50.000 Chinese Yuan	56.0 (71.8%)	43.0 (100%)	13.0 (37.1%)	
50.000–100.000 Chinese Yuan	11.0 (14.1%)	0.00 (0.00%)	11.0 (31.4%)	
> 100.00 Chinese Yuan	11.0 (14.1%)	0.00 (0.00%)	11.0 (31.4%)	< 0.001 [b]
Physical Exercise (Yes), n (%)	27.0 (34.6%)	14.0 (32.6%)	13.0 (37.1%)	0.672 [b]

Note: [a]: *P*-value for T-tests (normalized data); [b]: *P*-value for Mann-Whitney *U* tests (non-normalized data); [c]: *P-value for χ^2 tests for nominal variables;* [d]: The monetary unit of China.

Table S4. LCMs concentration (ng/mL) in serum in total participants (DF < 20%).

	DF (%)	min	P_5	P_{15}	P_{25}	P_{50}	P_{75}	P_{95}	max
EDPrB	19.2				< LOD			0.48	0.84
TPrECB	19.2				< LOD			3.00	4.82
DFECB	17.9				< LOD			2.37	3.48
DECB	16.7				< LOD			3.15	7.30
TPeCB	12.8				< LOD			0.49	3.76
EBMB	11.5				< LOD			2.51	10.2
3CHB	11.5				< LOD			2.93	5.15
TrPrB	11.5				< LOD			0.76	1.95
DPrECB	11.5				< LOD			1.41	2.33
DTMDEB	10.3				< LOD			0.14	0.31
DTMDPB	10.3				< LOD			0.22	0.56
BCEDB	10.3				< LOD			1.33	1.61
FPCB	8.97				< LOD			2.69	4.43
TePT	8.97				< LOD			0.19	0.47
DPrCB	7.69				< LOD			1.20	3.34
EBDMB	7.69				< LOD			4.49	7.26
DPeCB	7.69				< LOD			0.49	8.81
3eCHB	6.41				< LOD			2.13	4.79
4CHB	6.41				< LOD			2.31	4.71
DBCB	6.41				< LOD			2.19	22.2
TPeBB	5.13				< LOD			0.10	0.24
DPeBB	5.13				< LOD			0.62	1.08
TPrCB	3.85				< LOD			5.78E-02	5.56
FPB	3.85				< LOD			1.36E-02	1.12
DPrBB	3.85				< LOD			2.02E-02	1.44
MOPB	2.56				< LOD				29.5
MPhBB	2.56				< LOD				2.85
4CB	2.56				< LOD				0.72
EBCTFP	2.56				< LOD				4.64
FPePrB	2.56				< LOD				4.44
3OCB	1.28				< LOD				0.24
DFPVBC	1.28				< LOD				5.69
TrPeB	1.28				< LOD				0.99

Table S5. Associations [Coef. (95% CIs)] between Serum LCMs with Blood Lipids Indices in Qingyuan population.

Compounds		TC		TG		HDL-C		LDL-C	
		Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value
MPB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.69 (−0.28, 1.66)	0.173	0.28 (−0.45, 1.00)	0.459	0.08 (−0.21, 0.38)	0.584	0.43 (−0.37, 1.23)	0.297
	T3	0.65 (−0.16, 1.46)	0.126	0.22 (−0.39, 0.82)	0.483	−0.03 (−0.28, 0.22)	0.820	0.54 (−0.13, 1.21)	0.121
	Per unit increasion	0.00 (−0.34, 0.34)	0.987	0.08 (−0.16, 0.33)	0.519	−0.06 (−0.16, 0.04)	0.260	0.04 (−0.24, 0.32)	0.785
EDPBB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.20 (−1.10, 0.71)	0.672	0.04 (−0.61, 0.70)	0.894	−0.18 (−0.44, 0.09)	0.197	0.03 (−0.71, 0.77)	0.947
	T3	0.28 (−0.59, 1.15)	0.528	−0.16 (−0.80, 0.47)	0.615	0.02 (−0.23, 0.27)	0.865	0.30 (−0.41, 1.02)	0.414
	Per unit increasion	0.06 (−0.28, 0.40)	0.726	−0.04 (−0.28, 0.21)	0.769	−0.03 (−0.13, 0.07)	0.587	0.11 (−0.17, 0.39)	0.450
EDPeB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.33 (−1.26, 1.92)	0.689	0.17 (−0.96, 1.30)	0.771	−0.47 (−0.90, −0.04)	0.040	0.66 (−0.62, 1.94)	0.323
	T3	0.41 (−1.30, 2.11)	0.643	0.55 (−0.66, 1.76)	0.380	−-0.58 (−1.04, −0.11)	0.020	0.84 (−0.53, 2.22)	0.237
	Per unit increasion	0.09 (−0.78, 0.95)	0.842	0.29 (−0.33, 0.90)	0.369	−0.32 (−0.56, −0.09)	0.009	0.33 (−0.37, 1.03)	0.360
EtCBN	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.84 (−1.89, 0.21)	0.126	0.09 (−0.69, 0.87)	0.823	−0.15 (−0.47, 0.17)	0.359	−0.65 (−1.52, 0.23)	0.157
	T3	−0.69 (−1.53, 0.15)	0.116	−0.25 (−0.88, 0.38)	0.446	−0.13 (−0.39, 0.12)	0.314	−0.41 (−1.11, 0.29)	0.260
	Per unit increasion	−0.36 (−0.75, 0.04)	0.085	−0.09 (−0.38, 0.21)	0.567	−0.07 (−0.19, 0.05)	0.260	−0.22 (−0.55, 0.11)	0.192
PFPT	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.40 (−1.32, 0.52)	0.398	0.26 (−0.35, 0.87)	0.415	−0.14 (−0.40, 0.11)	0.283	−0.27 (−1.03, 0.48)	0.480
	T3	0.01 (−0.83, 0.84)	0.986	0.74 (0.18, 1.30)	0.014	−0.25 (−0.49, −0.02)	0.039	0.06 (−0.62, 0.75)	0.855
	Per unit increasion	−0.08 (−0.43, 0.27)	0.671	0.26 (0.02, 0.50)	0.040	−0.10 (−0.20, 0.00)	0.053	−0.03 (−0.31, 0.26)	0.850
TPrBB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.45 (−1.88, 0.98)	0.538	0.41 (−0.61, 1.43)	0.439	−0.11 (−0.53, 0.31)	0.597	−.18 (−1.36, 1.00)	0.765
	T3	−0.14 (−0.91, 0.62)	0.719	0.26 (−0.29, 0.81)	0.360	−0.07 (−0.29, 0.16)	0.551	−0.09 (−0.73, 0.54)	0.773
	Per unit increasion	−0.06 (−0.41, 0.29)	0.758	0.14 (−0.11, 0.39)	0.287	−0.03 (−0.14, 0.07)	0.511	−0.02 (−0.31, 0.26)	0.869
DPrB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.18 (−2.05, 2.42)	0.873	−0.38 (−1.96, 1.20)	0.639	0.41 (−0.23, 1.05)	0.215	−0.24 (−2.06, 1.59)	0.801
	T3	−0.42 (−1.22, 0.37)	0.303	0.44 (−0.12, 1.00)	0.136	−0.14 (−0.37, 0.08)	0.221	−0.40 (−1.04, 0.25)	0.240
	Per unit increasion	−0.18 (−0.56, 0.19)	0.350	0.18 (−0.08, 0.45)	0.186	−0.05 (−0.16, 0.06)	0.378	−0.18 (−0.49, 0.12)	0.247
EFPT	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−2.91 (−5.20, −0.61)	0.018	−1.75 (−3.44, −0.07)	0.049	0.52 (−0.19, 1.22)	0.164	−2.59 (−4.42, −0.75)	0.009
	T3	0.05 (−0.63, 0.73)	0.884	−0.34 (−0.84, 0.17)	0.198	0.10 (−0.11, 0.31)	0.356	0.12 (−0.43, 0.67)	0.675
	Per unit increasion	−0.01 (−0.37, 0.34)	0.942	−0.18 (−0.43, 0.07)	0.172	0.05 (−0.05, 0.16)	0.301	0.02 (−0.27, 0.31)	0.905
EDPB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−3.05 (−5.29, −0.80)	0.012	−1.78 (−3.36, −0.21)	0.033	0.48 (−0.23, 1.19)	0.193	−2.72 (−4.53, −0.91)	0.006
	T3	−0.36 (−1.07, 0.34)	0.315	−0.64 (−1.13, −0.14)	0.016	0.06 (−0.17, 0.28)	0.625	−0.24 (−0.80, 0.33)	0.414
	Per unit increasion	−0.25 (−0.60, 0.11)	0.186	−0.34 (−0.58, −0.11)	0.008	0.04 (−0.06, 0.15)	0.427	−0.18 (−0.48, 0.11)	0.229
8OCB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.03 (−0.72, 0.77)	0.941	0.07 (−0.47, 0.61)	0.806	−0.08 (−0.30, 0.14)	0.494	0.10 (−0.51, 0.71)	0.757
	T3	-	-	-	-	-	-	-	-
	Per unit increasion	0.03 (−0.33, 0.39)	0.866	0.04 (−0.22, 0.30)	0.759	−0.04 (−0.14, 0.07)	0.480	0.06 (−0.23, 0.36)	0.687

Note: Each LCM concentration was categorized into tertiles. T1: tertiles 1; T2: tertiles 2; T3: tertiles 3; -: No data available, the model cannot be fitted. Adjusted model: adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

Table S6. Associations [Coef. (95% CIs)] between Serum LCMs with Blood Lipids Indices in Guangzhou population.

Compounds		TC		TG		HDL-C		LDL-C	
		Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value	Coef. (95% CI)	*P*-value
EDPeB	T1	Reference		Reference		Reference		Reference	
	T2	−0.51 (−1.10, 0.08)	0.100	−0.24 (−0.57, 0.09)	0.168	−0.11 (−0.34, 0.13)	0.376	−0.26 (−0.70, 0.18)	0.260
	T3	0.29 (−0.29, 0.88)	0.330	0.14 (−0.19, 0.46)	0.416	0.11 (−0.12, 0.34)	0.372	0.11 (−0.32, 0.55)	0.616
	Per unit increasion	−0.18 (−0.49, 0.13)	0.270	0.04 (−0.14, 0.23)	0.642	−0.10 (−0.23, 0.03)	0.144	−0.13 (−0.34, 0.09)	0.263
MPB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.23 (−0.86, 0.39)	0.473	0.02 (−0.32, 0.36)	0.908	−0.07 (−0.31, 0.16)	0.542	−0.16 (−0.60, 0.28)	0.479
	T3	−0.01 (−0.64, 0.63)	0.980	0.08 (−0.27, 0.43)	0.666	−0.01 (−0.24, 0.23)	0.961	−0.12 (−0.57, 0.33)	0.610
	Per unit increasion	−0.04 (−0.35, 0.26)	0.792	0.06 (−0.13, 0.24)	0.555	0.03 (−0.09, 0.16)	0.612	−0.07 (−0.28, 0.14)	0.539
PPB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.33 (−1.12, 0.45)	0.410	−0.08 (−0.51, 0.36)	0.733	−-0.13 (−0.43, 0.16)	0.386	−0.16 (−0.72, 0.40)	0.577
	T3	0.07 (−0.48, 0.63)	0.803	0.04 (−0.27, 0.34)	0.817	−0.06 (−0.27, 0.15)	0.565	0.03 (−0.37, 0.43)	0.883
	Per unit increasion	−0.08 (−0.33, 0.18)	0.560	0.05 (−0.10, 0.20)	0.548	−0.09 (−0.19, 0.02)	0.125	−0.05 (−0.22, 0.13)	0.607
TPrECB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.30 (−0.65, 1.26)	0.540	−0.10 (−0.61, 0.41)	0.702	0.08 (−0.26, 0.43)	0.638	0.28 (−0.39, 0.95)	0.422
	T3	0.25 (−0.30, 0.81)	0.379	−0.18 (−0.48, 0.12)	0.254	0.17 (−0.03, 0.37)	0.116	0.14 (−0.25, 0.53)	0.495
	Per unit increasion	0.20 (−0.07, 0.47)	0.160	−0.03 (−0.19, 0.13)	0.746	0.11 (0.00, 0.22)	0.073	0.10 (−0.09, 0.28)	0.309
BVBC	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.17 (−1.05, 1.39)	0.780	−0.09 (−0.66, 0.47)	0.746	0.06 (−0.40, 0.52)	0.796	0.18 (−0.68, 1.04)	0.689
	T3	0.19 (−0.36, 0.75)	0.500	0.41 (0.15, 0.67)	0.004	−0.01 (−0.22, 0.20)	0.908	0.05 (−0.34, 0.45)	0.789
	Per unit increasion	0.20 (−0.08, 0.49)	0.179	0.17 (0.00, 0.35)	0.058	0.05 (−0.07, 0.17)	0.449	0.07 (−0.13, 0.27)	0.479
TePrB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.84 (−0.81, 2.49)	0.331	−0.14 (−1.03, 0.75)	0.758	0.39 (−0.22, 0.99)	0.222	0.63 (−0.52, 1.78)	0.293
	T3	0.04 (−0.51, 0.59)	0.892	0.15 (−0.15, 0.44)	0.336	−0.05 (−0.25, 0.15)	0.606	0.09 (−0.29, 0.47)	0.654
	Per unit increasion	−0.11 (−0.41, 0.20)	0.490	0.06 (−0.12, 0.24)	0.504	−0.06 (−0.19, 0.07)	0.352	−0.04 (−0.25, 0.18)	0.747
PFPT	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	0.18 (−2.05, 2.42)	0.873	−0.38 (−1.96, 1.20)	0.639	0.41 (−0.23, 1.05)	0.215	−0.24 (−2.06, 1.59)	0.801
	T3	−0.42 (−1.22, 0.37)	0.303	0.44 (−0.12, 1.00)	0.136	−0.14 (−0.37, 0.08)	0.221	−0.40 (−1.04, 0.25)	0.240
	Per unit increasion	−0.18 (−0.56, 0.19)	0.350	0.18 (−0.08, 0.45)	0.186	−0.05 (−0.16, 0.06)	0.378	−0.18 (−0.49, 0.12)	0.247
BDPrB	T1	Reference	-	Reference	-	Reference	-	Reference	-
	T2	−0.59 (−1.12, −0.06)	0.040	−0.18 (−0.48, 0.13)	0.266	0.01 (−0.20, 0.22)	0.934	−0.44 (−0.81, −0.08)	0.025
	T3	-	-	-	-	-	-	-	-
	Per unit increasion	−0.21 (−0.46, 0.05)	0.130	−0.09 (−0.24, 0.07)	0.276	0.03 (−0.08, 0.13)	0.611	−0.17 (−0.35, 0.00)	0.069

Note: Each LCM concentration was categorized into tertiles. T1: tertiles 1; T2: tertiles 2; T3: tertiles 3; -: No data available, the model cannot be fitted. Adjusted model: adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

Table S7. Specific weights for the contribution of individual LCMs to the change in lipid levels.

Compounds	Total populations				Qingyuan				Guangzhou			
	TC	TG	HDL-C	LDL-C	TC	TG	HDL-C	LDL-C	TC	TG	HDL-C	LDL-C
EtCBN	0.256	0.245	0.294	0.296	0.235	0.112	0.225	6.98E-02	-	-	-	-
EDPeB	4.07E-02	6.03E-02	8.14E-02	3.81E-02	1.90E-02	4.70E-02	0.179	4.71E-02	7.02E-02	8.59E-02	1.75E-02	7.51E-02
TPrBB	0.106	0.111	1.99E-02	2.68E-02	5.80E-02	0.106	4.10E-02	0.121	-	-	-	-
PFPT	0.161	0.197	0.388	0.120	4.00E-02	0.044	9.60E-02	8.12E-02	0.297	0.196	0.369	0.256
PPB	9.86E-02	8.78E-02	4.41E-02	0.315	-	-	-	-	0.162	0.189	9.63E-02	8.04E-02
MPB	0.127	0.161	0.117	0.160	0.125	0.171	2.60E-02	2.72E-02	5.69E-02	6.64E-02	8.16E-02	8.09E-02
EDPBB	0.210	0.138	5.59E-02	4.38E-02	7.30E-02	0.034	1.20E-02	2.69E-02	-	-	-	-
EDPB	-	-	-	-	0.108	0.117	9.60E-02	0.214	-	-	-	-
EFPT	-	-	-	-	4.70E-02	0.107	2.00E-02	9.93E-02	-	-	-	-
DPrB	-	-	-	-	0.213	0.170	0.206	0.270	-	-	-	-
8OCB	-	-	-	-	0.084	0.091	0.101	4.31E-02	-	-	-	-
TPrECB	-	-	-	-	-	-	-	-	0.220	0.219	0.177	0.314
TePrB	-	-	-	-	-	-	-	-	7.78E-02	0.120	0.127	7.29E-02
BDPrB	-	-	-	-	-	-	-	-	6.23E-02	7.36E-02	3.14E-02	2.29E-02
BVBC	-	-	-	-	-	-	-	-	5.38E-02	5.01E-02	0.100	9.78E-02

Note: -: No data.
The gWQS models were adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

2. Supplementary figures

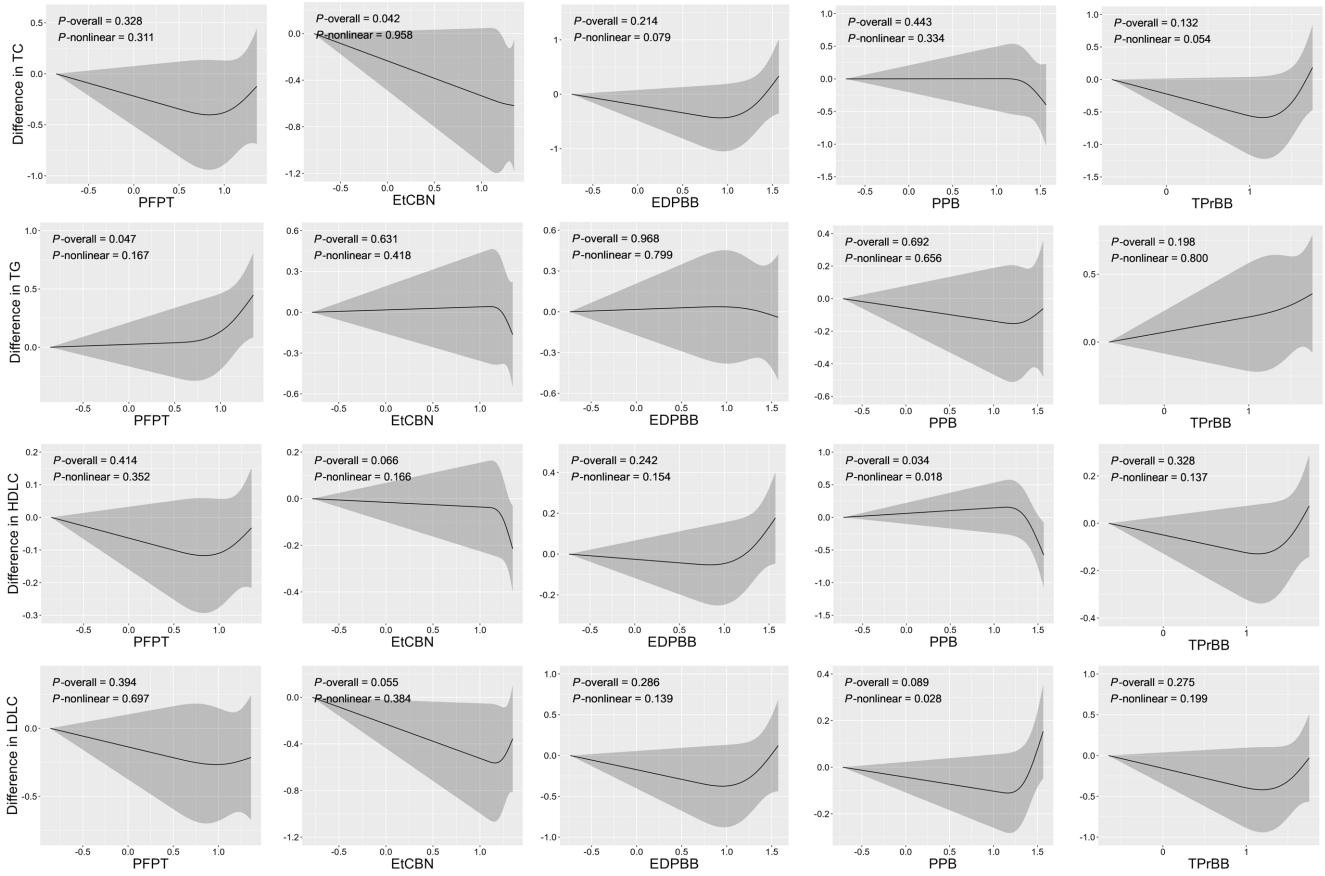

Figure S1. Dose-response relationships between LCMs and blood lipid levels in all participants. Note: PFPT, EtCBN, EDPBB, PPB, and TPrBB are the five LCMs with the lowest DF above 30%. The RCS model was adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

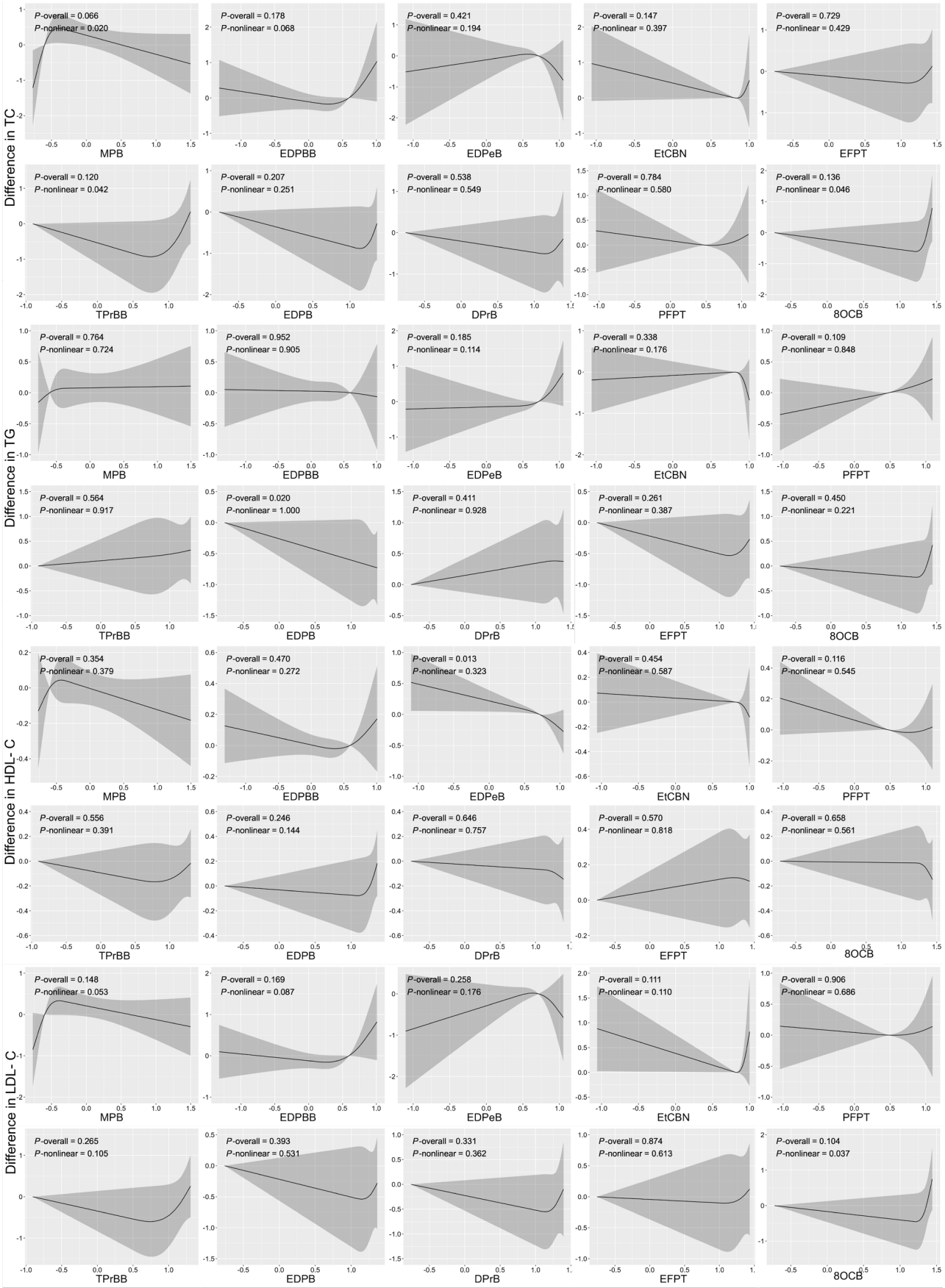

Figure S2. Dose-response relationships between LCMs (DF > 30%) and blood lipid levels in Qingyuan population. The RCS model was adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

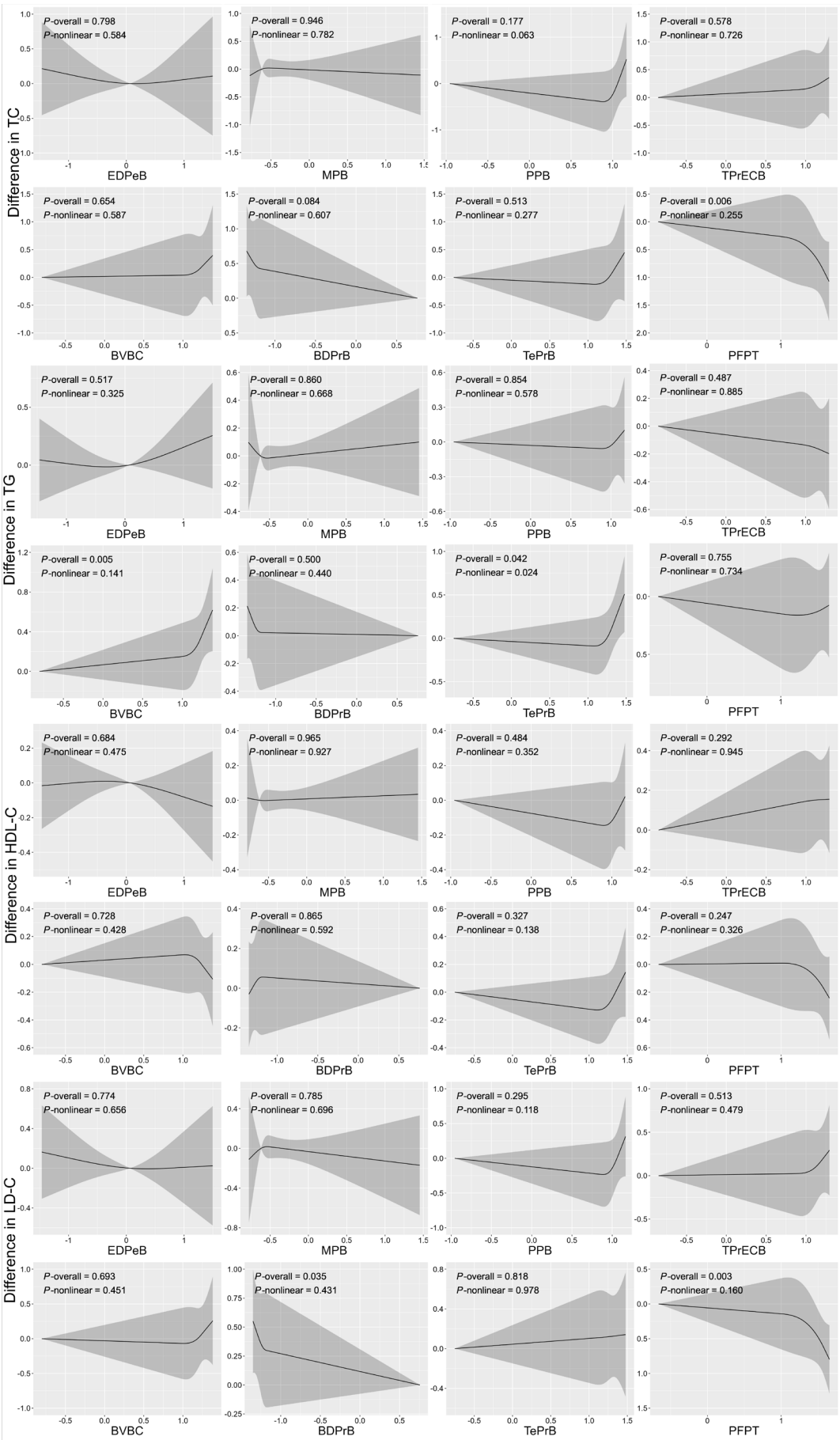

Figure S3. Dose-response relationships between LCMs (DF > 30%) and blood lipid levels in Guangzhou population. The RCS model was adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

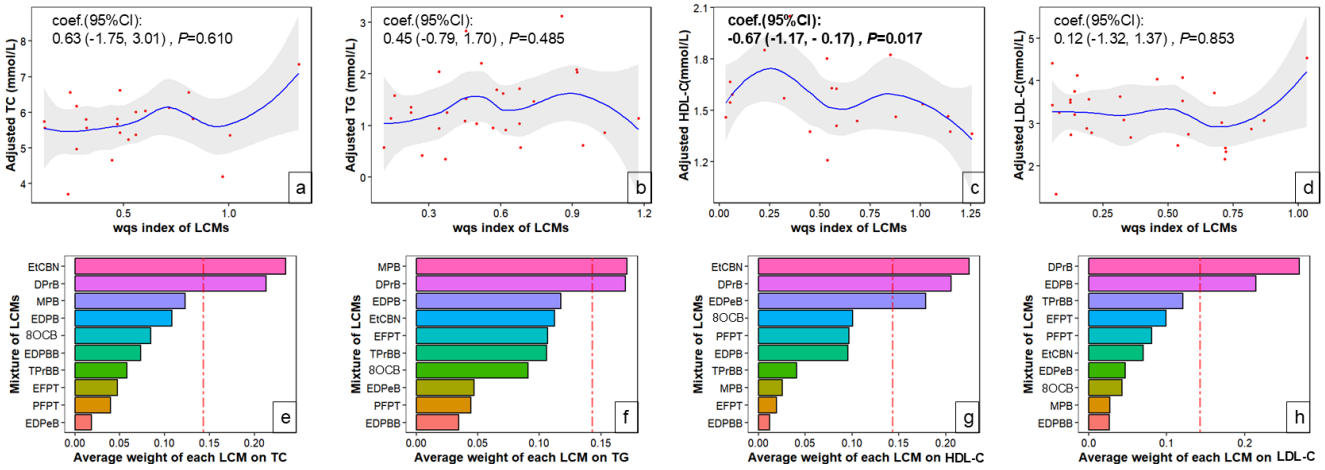

Figure S4. Overall dose-effect of exposure to LCM mixture on lipid levels and the contribution of individual pollutant in Qingyuan population. Abbreviation: wqs, weighted quartile sum index for representing the overall exposure load of the LCM mixture; Coef. 95 % CIs: Coefficients and 95 % Confidence Intervals. The gWQS models were adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

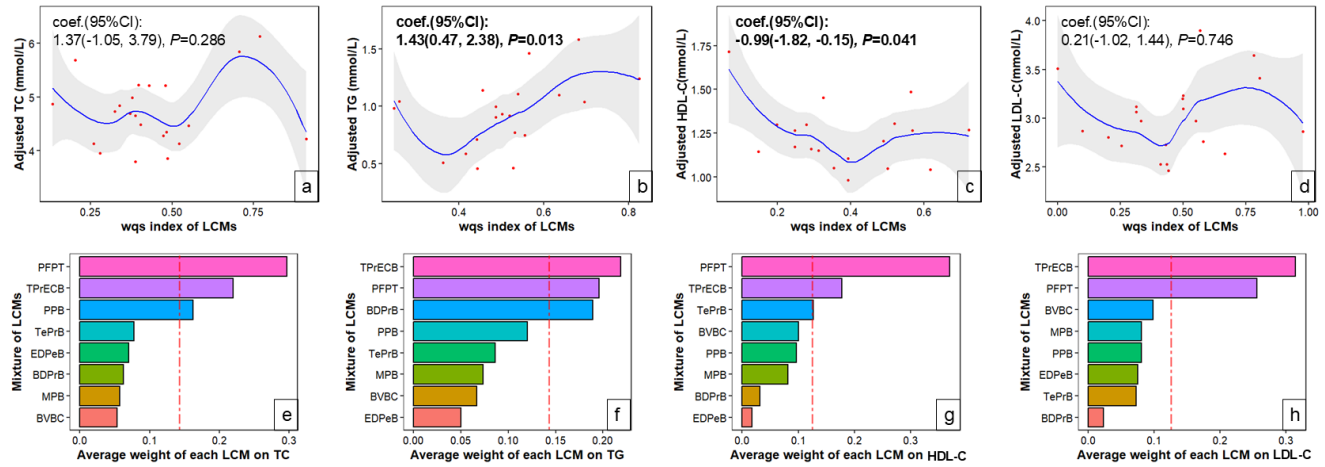

Figure S5. Overall dose-effect of exposure to LCM mixture on lipid levels and the contribution of individual pollutant in Guangzhou population. The gWQS models were adjusted for age, sex, BMI, smoking, alcohol and physical exercise.

References

[1] Shen M, Feng Z, Liang X, Chen H, Zhu C, *et al*. Release and gas-particle partitioning behavior of liquid crystal monomers during the dismantling of waste liquid crystal display panels in e-waste recycling facilities. *Environ. Sci. Technol.* 2022, 56(5):3106–3116. DOI: 10.1021/acs.est.1c07394