Fatty acid	Corn oil (%)	Fish oil (%)
C16:1	10.433	0.121
C18:0	3.354	0.032
C18:1	18.403	0.492
C18:2	56.753	1.625
C18:3n-6	9.692	0.170
C20:3n-6	-	3.452
C20:5n-3	0.082	52.579
C22:6n-3	0.047	25.720

1   Supplementary Table 1. Fatty acid composition of different interventions.

2

Variable		FOD	p^a	FO	p^a	CO	p^a	P^b FO +D vs FO	P^b FO + D vs CO	P^b FO vs CO	P^c
Demographic factors											
No. of subjects		22		20		19					
Age (years)		56.41 ± 15.84		54.25± 15.32		58.42 ± 13.74		0.80	0.84	0.61	0.69
Gender	Male	11	50% [d]	12	60% [d]	11	58% [d]	0.52[e]	0.61[e]	0.89[e]	0.78[e]
	Female	11	50% [d]	8	40% [d]	8	42% [d]				
Smoker		6	27% [d]	4	20% [d]	7	37% [d]	0.58[e]	0.51[e]	0.24[e]	0.50[e]
Drinker	<140g for male or <70g for female	4	18% [d]	4	20% [d]	5	26% [d]	0.88[e]	0.53[e]	0.64[e]	0.80[e]
Prevalence	Hypertension	3	14% [d]	4	20% [d]	3	16% [d]	0.58[e]	0.85[e]	0.73[e]	0.85[e]
	Diabetes	2	9% [d]	3	15% [d]	2	11% [d]	0.56[e]	0.88[e]	0.68[e]	0.83[e]
	Hyperlipidemia	3	14% [d]	9	45% [d]	5	26% [d]	0.06[e]	0.53[e]	0.22[e]	0.15[e]
Current medical treatment n (%)	Hypotensive drugs	3	14% [d]	3	12% [d]	3	16% [d]	0.74[e]	0.93[e]	0.81[e]	0.94[e]
	Hypoglycemic drugs	1	5% [d]	3	12% [d]	1	5% [d]	0.32[e]	0.96[e]	0.35[e]	0.48[e]
	Lipid-lowing drugs	3	14% [d]	5	25% [d]	5	26% [d]	0.48[e]	0.35[e]	0.81[e]	0.64[e]
Anthropometric measurement											
Height (cm)		165.16 ± 8.83		166.58 ± 11.85		168.74 ± 9.07		0.34	0.23	0.68	0.25
Weight (kg)	Day 0	71.88 ± 10.29	0.96	75.34 ± 11.99	0.68	75.60 ± 12.12	0.92	0.30	0.27	0.74	0.29
	Day 90	71.96 ± 10.49		76.24 ± 12.20		76.12 ± 13.19		0.25	0.28	0.99	0.25
	Changes	0.08 ± 1.77		0.90 ± 1.79		0.52 ± 2.80		0.21	0.37	0.88	0.48

BMI (kg/m²)	Day 0	26.27 ± 2.44	0.85	27.46 ± 4.62	0.68	26.41 ± 2.39	0.85	0.79	0.88	0.78	0.86
	Day 90	26.34 ± 2.66		27.24 ± 3.41		26.58 ± 2.75		0.55	0.88	0.67	0.76
	Changes	0.07 ± 0.65		-0.22 ± 2.07		0.17 ± 0.89		0.50	0.43	0.80	0.83
Biochemical indicators											
TAG	Day 0	1.63 ± 0.67	0.05	2.68 ± 1.35	0.03	1.73 ± 0.67	0.24	0.10	0.69	0.10	0.65
	Day 90	1.32 ± 0.71		1.78 ± 0.62		1.75 ± 1.38		0.001	0.34	0.06	0.14
	Changes	-0.45 ± 0.63		-0.90± 0.95		0.02 ± 1.01		0.16	0.28	0.01	0.12
TC	Day 0	5.33 ± 1.20	0.70	4.83 ± 1.07	0.55	5.06 ± 0.93	0.63	0.17	0.49	0.62	0.41
	Day 90	5.30 ± 1.22		4.62 ± 1.03		5.14 ± 0.83		0.07	0.91	0.07	0.57
	Changes	-0.03 ± 0.98		-0.21 ± 0.84		0.08± 0.54		0.70	0.61	0.28	0.72
ALT (U/L)	Day 0	26.86 ± 14.04	0.12	25.25 ± 12.24	0.21	30.68 ± 30.55	0.42	1.00	0.78	0.64	0.56
	Day 90	20.09 ± 8.09		22.65 ± 12.31		30.21 ± 30.64		0.85	0.68	0.98	0.09
	Changes	-6.77± 10.58		-2.60 ± 9.72		-0.47 ± 5.80		0.19	0.01	0.40	0.02
AST (U/L)	Day 0	22.82 ± 7.90	0.29	21.80 ± 4.92	0.67	22.58 ± 8.91	0.86	0.71	0.86	0.59	0.90
	Day 90	19.77 ± 4.07		21.40 ± 5.33		23.37 ± 9.69		0.28	0.29	0.80	0.08
	Changes	-3.05 ± 6.20		-0.40 ± 4.64		0.79 ± 3.61		0.38	0.01	0.28	0.01
GGT (U/L)	Day 0	34.95 ± 36.06	0.23	27.30 ± 19.19	0.88	29.84 ± 20.84	0.77	0.47	0.80	0.44	0.52
	Day 90	23.18 ± 10.73		23.65 ± 12.19		30.89 ± 25.78		0.97	0.35	0.49	0.16
	Changes	-11.77 ± 33.87		-3.65 ± 10.35		1.05 ± 8.97		0.14	0.02	0.37	0.06
HDL-C	Day 0	1.24 ± 0.27	0.34	1.04 ± 0.24	0.69	1.23 ± 0.39	0.94	0.20	0.67	0.14	0.83
	Day 90	1.20 ± 0.33		1.29 ± 0.29		1.07 ± 0.27		0.01	0.49	0.11	0.59
	Changes	0.05 ± 0.12		0.03 ± 0.17		0.17 ± 0.16		0.80	0.35	0.63	0.44
LDL-C	Day 0	3.67 ± 1.09	0.68	2.85 ± 1.06	0.78	3.36 ± 0.83	0.82	0.10	0.27	0.06	0.31
	Day 90	3.67 ± 1.10		2.90 ± 0.95		3.46 ± 0.79		0.01	0.70	0.04	0.43
	Changes	0.01 ± 0.66		0.05 ± 0.98		0.09 ± 0.62		0.64	0.75	0.86	0.72
Insulin (mmol/L)	Day 0	13.24 ± 2.99	0.02	13.53 ± 2.05	0.07	13.60 ± 2.53	0.53	0.23	0.45	0.97	0.65

	Day 90	11.54± 1.61		12.64 ± 2.61		13.08 ± 2.25		0.20	0.02	0.34	0.02
	Changes	-1.70 ± 2.04		-0.8 9± 2.48		-0.52 ± 1.67		0.38	0.03	0.31	0.07
Glucose	Day 0	6.31 ± 2.05	0.57	5.76 ± 1.20	0.10	6.18 ± 1.33	0.57	0.27	0.63	0.24	0.76
	Day 90	6.40 ± 1.98		6.13 ± 1.27		6.34 ± 1.00		0.81	0.24	0.23	0.29
	Changes	0.09 ± 0.61		0.38 ± 0.43		0.16 ± 0.79		0.12	0.35	0.82	0.65
HOMA-IR	Day 0	3.68 ± 1.26	0.37	3.51 ± 1.13	0.91	3.71± 0.88	0.65	0.76	0.57	0.34	0.95
	Day 90	3.27 ± 1.02		3.42 ± 0.84		3.67 ± 0.72		0.41	0.04	0.16	0.15
	Changes	-0.41 ± 0.70		-0.10 ± 0.84		-0.04 ± 0.59		0.16	0.12	0.89	0.10
BUN, μmol/L	Day 0	5.16 ± 0.79	0.93	4.87 ± 1.14	0.68	5.34 ± 0.76	0.94	0.31	0.43	0.16	0.58
	Day 90	5.24 ± 1.03		5.10 ± 1.20		5.48 ± 0.89		0.55	0.42	0.18	0.75
	Changes	0.08 ± 1.02		0.23 ± 0.75		0.15 ± 1.00		0.75	0.93	0.48	0.79
Creatinine, μmol/L	Day 0	68.95 ± 13.81	0.72	70.50 ± 11.64	0.57	70.79 ± 9.99	0.79	0.73	0.63	0.77	0.62
	Day 90	70.23 ± 12.22		72.70 ± 12.06		71.32 ± 10.97		0.41	0.67	0.82	0.75
	Changes	1.27 ± 6.10		2.20 ± 6.68		0.53 ± 6.27		0.56	0.68	0.41	0.73
Urea acid, μmol/L	Day 0	358.90 ± 86.69	0.58	401.15 ± 103.66	0.37	360.11 ± 91.83	0.77	0.26	0.90	0.36	0.92
	Day 90	384.64 ± 80.98		370.15 ± 109.80		363.16 ± 86.98		0.40	0.49	0.96	0.48
	Changes	-15.00 ± 56.85		-31 ± 90.98		3.05 ± 40.15		0.79	0.48	0.19	0.41
Adiponectin	Day 0	4.28 ± 2.80	0.15	3.35 ± 1.95	0.07	4.16 ± 2.25	0.37	0.36	0.88	0.22	0.83
	Day 90	6.00 ± 4.35		4.57 ± 2.31		4.79 ± 2.56		0.42	0.51	0.80	0.22
	Changes	1.73 ± 2.99		1.22 ± 1.55		0.63 ± 2.27		0.84	0.07	0.07	0.14
IL-1β(ng/L)	Day 0	23.62 ± 33.59	0.31	24.04 ± 31.22	0.14	18.17 ± 13.27	0.10	0.83	0.86	0.80	0.54
	Day 90	24.04 ± 28.11		18.61 ± 24.63		14 .16 17.94		0.29	0.15	0.38	0.36
	Changes	-7.08 ± 7.56		-4.97 ± 6.08		1.28 ± 6.35		0.35	<0.001	<0.05	<0.001
IL-6 (ng/L)	Day 0	9.16 ± 11.61	0.94	6.13 ± 6.85	0.05	5.02± 5.04	0.23	0.23	0.11	0.69	0.11
	Day 90	8.85 ± 10.99		7.25 ± 6.00		6.12 ± 4.74		0.64	0.66	0.42	0.27
	Changes	-0.31± 1.92		1.12 ± 1.93		1.11 ± 2.82		0.02	0.07	0.69	0.04

			P^a		P^b		P^c				
TNF-α (ng/L)	Day 0	447.83 ± 393.24	0.001	362.66 ± 335.56	0.01	327.36 ± 237.11	0.29	0.27	0.30	0.87	0.24
	Day 90	265.18 ± 439.22		219.14 ± 278.15		179.76 ± 197.12		0.95	0.93	0.68	0.40
	Changes	-173.56 ± 102.26		-113.52 ± 157.65		-21.29 ± 102.13		0.27	<0.001	0.001	<0.001
FGF-21 (pg/ml)	Day 0	107.62 ± 64.74	0.44	114.36 ± 62.83	0.81	99.12 ± 67.25	0.57	0.71	0.61	0.35	0.69
	Day 90	92.89 ± 59.08		109.40 ± 52.72		111.72 ± 74.14		0.31	0.43	0.76	0.32
	Changes	-14.73 ± 28.051		-4.96 ± 26.50		12.60 ± 26.19		0.42	0.01	0.06	0.001
Nutrition intake											
Carbohydrate, g	Day 0	228.31 ± 60.21	0.80	329.75 ± 137.77	0.13	265.50 ± 99.51	0.69	0.10	0.33	0.20	0.34
	Day 90	269.78 ± 148.52		258.95 ± 80.63		263.14 ± 124.33		0.63	0.93	0.67	0.86
	Changes	72.68 ± 160.60		-62.95 ± 117.56		10.63 ± 136.73		0.20	0.32	0.13	0.26
Fat, kcal	Day 0	83.03 ± 36.71	0.44	93.80 ± 27.46	0.75	85.52 ± 27.95	0.51	0.27	1.00	0.27	0.82
	Day 90	97.84 ± 58.86		102.19 ± 19.70		93.38 ± 38.67		0.41	0.88	0.84	0.78
	Changes	23.68 ± 38.93		13.61 ± 52.95		13.36 ± 40.35		0.69	0.48	0.74	0.52
Protein, kcal	Day 0	75.29 ± 32.73	0.84	88.27 ± 37.24	0.83	85.82 ± 23.78	0.43	0.41	0.39	0.82	0.35
	Day 90	90.30 ± 66.29		85.28 ± 36.78		80.51 ± 30.49		0.93	0.91	0.86	0.52
	Changes	29.30 ± 64.49		-0.05 ± 32.18		-1.81 ± 29.95		0.16	0.06	0.65	0.06

4 Supplementary Table 2 Characteristics of subjects according to NAFLD.

5 P^a is for the differences between the baseline and endpoint of intervention by a paired Wilcoxon rank sum test; P^b is for the differences between two groups by Wilcoxon rank

6 sum test; P^c is for the differences between three groups by a generalized linear model; [d]: percentages was used to express the category variables; [e]: is for the differences between

7 gender by chi-square test. Abbreviations: ALT: alanine transaminase; AST: aspartate aminotransferase; BMI: body mass index; BUN: blood urea nitrogen; FGF21: fibroblast

8 growth factor 21; GGT: gamma-glutamyl transpeptidase; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; IL-1β, interleukin-1β; IL-

9 6, interleukin-6; TAG: triacylglycerol; TC: total cholesterol; TNF-α: tumor necrosis factor-α.

10

	Detected mass (m/z)	Retention time (min)	Formula	Putative identification	FC	p
FOD vs FO	453.33180	5.216	$C_{27}H_{44}O_3$	1,25-dihydroxyvitamin D_3	5.42	<0.001
	357.26750	9.235	$C_{24}H_{36}O_2$	THA (C24:6, n-3)	2.05	0.03
FOD vs CO	433.29160	10.357	$C_{27}H_{44}O_4$	1,24,25-trihydroxyvitamin D_3	7.70	<0.001
	339.21470	12.082	$C_{20}H_{34}O_4$	8,9-DiHETrE	0.05	<0.05
FO vs CO	462.33430	4.529	$C_{52}H_{91}O_{11}P$	PG (22:6-OH (17)/i-24:0)	0.003	<0.001
FOD vs FO vs CO	453.33180	5.216	$C_{27}H_{44}O_3$	1,25-dihydroxyvitamin D_3		<0.001
	231.14930	6.879	$C_{12}H_{22}O_4$	Dodecanedioic acid		0.001

12 Supplementary Table 3. Characteristics of identified metabolites in compare FOD, FO and CO groups.

13 FC: Fold change; PG: phosphatidyl glycerol; THA: tetracosahexaenoic acid.

14

	Detected mass (m/z)	Retention time (min)	Formula	Putative identification	FC	p
FOD	373.27610	5.177	$C_{43}H_{69}O_8P$	PA (22:6/18:2)	3.56	0.02
	453.33180	5.216	$C_{27}H_{44}O_3$	1,25-dihydroxyvitamin D_3	5.02	0.001
	307.22500	9.787	$C_{20}H_{34}O_2$	ETA (C20:3, n-3)	6.62	<0.001
FO	285.17750	10.115	$C_{16}H_{28}O_4$	Tetranorprostanedioic acid	7.85	<0.001
	283.21990	10.78	$C_{18}H_{34}O_2$	Octadecenoic acid	7.11	<0.001

15 Supplementary Table 4. Characteristics of identified metabolites between the baseline and endpoint of FOD and FO group. FC: Fold change; PA: phosphatidic acid; ETA:

16 eicosatrienoic acid.

17

Abbreviation	English full name
FO + D	Fish oil plus vitamin D group
FO	Fish oil group
CO	Control group
NAFLD	Nonalcoholic fatty liver disease
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
ASV	Amplicon Sequence Variants
BMI	Body mass index
CI	Confidence interval
DHA	Docosahexaenoic acid
EPA	Eicosapentaenoic acid
ETA	Eicosatrienoic acid
FBG	Fasting blood glucose
FC	Fold change
FGF-21	Fibroblast growth factor-21
GLM	Generalized linear model
HC	Hip circumference
HDL-C	High density lipoprotein cholesterol
HRP	Horse radish peroxidase
IL-1β	Interleukin 1β
IL-6	Interleukin 6
IR	Insulin resistant
LDL-C	Low density lipoprotein cholesterol
n-3 PUFA	n-3 polyunsaturated fatty acids
ORs	Odds ratios
OTU	Operational taxonomic units
OPLS-DDA	Orthogonal partial least-squares discrimination analysis
PA	Phosphatidic acid
PCR	Polymerase Chain Reaction
PLSDA	Partial Least Squares Discriminant Analysis
PUFA	Polyunsaturated fatty acids
SD	Standard deviation
TAG	Triglyceride
TC	Total cholesterol
TNF-α	Tumour necrosis factor-α
THA	Tetracosahexaenoic acid
UPLC	Ultra Performance Liquid Chromatography
VDR	Vitamin D receptor
VIP	Variable important in projection
WC	Waist circumference
WHR	Waist hip ratio