**Supplementary Figure S1.** Distinct regulation of individual lipid species in rat plasma at three time points. (A) principal component analysis (PCA) plot of all lipid species at day 1 post-irradiation. (B-D) PCA and volcano plot of all lipid species at day 1 post-irradiation between 5 Gy vs. 0 Gy, 10 Gy vs. 0 Gy, 10 Gy vs. 5 Gy, respectively. (E) PCA plot of all lipid species at day 7 post-irradiation. (F-H) PCA and volcano plot of all lipid species at day 7 post-irradiation between 5 Gy vs. 0 Gy, 10 Gy vs. 0 Gy, 10 Gy vs. 5 Gy, respectively. (I) PCA and volcano plot of all lipid species at day 14 post-irradiation between 5 Gy vs. 0 Gy. In each volcano plot, red dots represent lipids with false discovery rate (FDR) < 0.05 and fold change (FC) > 2, blue dots for lipids with FDR < 0.05 and FC < 0.5.

**Supplementary Table S1.** Distinctly regulated individual lipids (μg/ml, mean ± SEM) in rat plasma following exposure to 5 Gy irradiation at 1 d.

| Differential lipids（4↑ , 35↓） | Retention Time(min) | 0 Gy (*n*=5) (μg·ml⁻¹) | 5 Gy (*n*=5) (μg·ml⁻¹) | FC | log2(FC) | FDR | -log10(FDR) |
|---|---|---|---|---|---|---|---|
| DG(16:0/18:2) | 8.10 | 0.06±0.01 | 0.02±0.00 | 0.30 | -1.76 | 3.89E-02 | 1.41 |
| DG(16:0/20:4) | 8.23 | 5.31±0.79 | 1.68±0.15 | 0.48 | -1.07 | 3.89E-02 | 1.41 |
| DG(18:3/18:0) | 7.59 | 4.75±0.53 | 2.26±0.20 | 0.32 | -1.66 | 3.89E-02 | 1.41 |
| LPC(17:1) | 1.59 | 0.41±0.04 | 0.20±0.01 | 0.50 | -1.01 | 3.89E-02 | 1.41 |
| LPC(20:3) | 1.62 | 4.09±0.47 | 1.42±0.10 | 0.35 | -1.53 | 3.42E-02 | 1.47 |
| LPC(20:5) | 1.33 | 0.65±0.10 | 0.23±0.01 | 0.36 | -1.46 | 3.89E-02 | 1.41 |
| PE(18:0/22:5) | 7.90 | 0.07±0.01 | 0.03±0.00 | 0.41 | -1.29 | 4.55E-02 | 1.34 |
| SM(d18:2/18:2) | 4.95 | 0.02±0.00 | 0.06±0.00 | 2.23 | 1.16 | 3.42E-02 | 1.47 |
| SM(d18:3/20:1) | 6.01 | 0.02±0.00 | 0.04±0.00 | 2.42 | 1.27 | 3.89E-02 | 1.41 |
| TG48:4(18:2) | 11.06 | 0.04±0.01 | 0.01±0.00 | 0.32 | -1.64 | 3.89E-02 | 1.41 |
| TG54:8(22:6) | 11.19 | 0.02±0.00 | 0.01±0.00 | 0.26 | -1.97 | 3.96E-02 | 1.40 |
| TG51:3(18:2) | 12.08 | 0.88±0.16 | 0.19±0.03 | 0.21 | -2.23 | 3.89E-02 | 1.41 |
| TG51:4(18:2) | 11.72 | 0.74±0.11 | 0.22±0.04 | 0.29 | -1.76 | 3.89E-02 | 1.41 |
| TG51:5(18:3) | 11.35 | 0.02±0.00 | 0.01±0.00 | 0.31 | -1.69 | 3.89E-02 | 1.41 |
| TG51:5(18:2) | 11.35 | 0.04±0.01 | 0.01±0.00 | 0.30 | -1.75 | 3.89E-02 | 1.41 |
| TG54:7(22:6) | 11.50 | 0.25±0.03 | 0.12±0.01 | 0.47 | -1.08 | 4.10E-02 | 1.39 |
| TG52:3(18:2) | 12.28 | 42.3±7.14 | 10.64±1.60 | 0.25 | -1.99 | 3.89E-02 | 1.41 |
| TG56:5(22:4) | 12.46 | 1.59±0.22 | 0.61±0.11 | 0.38 | -1.38 | 3.89E-02 | 1.41 |
| TG52:4(18:2) | 11.93 | 38.66±4.83 | 13.08±1.80 | 0.34 | -1.56 | 3.89E-02 | 1.41 |
| TG52:5(18:3) | 11.57 | 1.66±0.26 | 0.51±0.08 | 0.31 | -1.69 | 3.89E-02 | 1.41 |
| TG60:12(22:6) | 11.23 | 0.06±0.01 | 0.35±0.04 | 6.32 | 2.66 | 1.32E-02 | 1.88 |
| TG52:6(20:4) | 11.21 | 0.12±0.02 | 0.02±0.00 | 0.19 | -2.36 | 3.89E-02 | 1.41 |
| TG54:8(20:5) | 11.11 | 0.07±0.01 | 0.02±0.00 | 0.35 | -1.5 | 4.55E-02 | 1.34 |
| TG53:3(18:2) | 12.47 | 0.68±0.11 | 0.19±0.03 | 0.28 | -1.85 | 3.89E-02 | 1.41 |
| TG55:5(20:4) | 12.38 | 0.01±0.00 | 0.01±0.00 | 0.41 | -1.28 | 3.96E-02 | 1.40 |
| TG53:4(18:2) | 12.13 | 0.32±0.07 | 0.05±0.01 | 0.17 | -2.58 | 3.92E-02 | 1.41 |
| TG53:5(18:2) | 11.79 | 0.19±0.03 | 0.05±0.01 | 0.26 | -1.92 | 3.89E-02 | 1.41 |
| TG54:3(18:2) | 12.66 | 3.94±0.65 | 1.13±0.18 | 0.29 | -1.8 | 3.89E-02 | 1.41 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TG54:3(18:1) | 12.66 | 17.75±3.76 | 3.60±0.50 | 0.20 | -2.3 | 3.96E-02 | 1.40 |
| TG54:4(18:2) | 12.34 | 23.07±3.71 | 6.10±0.92 | 0.26 | -1.92 | 3.89E-02 | 1.41 |
| TG54:5(18:2) | 11.99 | 20.81±2.48 | 7.39±1.17 | 0.36 | -1.49 | 3.89E-02 | 1.41 |
| TG54:6(18:3) | 11.64 | 1.50±0.21 | 0.47±0.08 | 0.31 | -1.69 | 3.89E-02 | 1.41 |
| TG55:4(19:1) | 12.51 | 0.15±0.03 | 0.03±0.00 | 0.23 | -2.15 | 3.89E-02 | 1.41 |
| TG54:6(18:2) | 11.63 | 13.42±1.88 | 4.50±0.80 | 0.34 | -1.58 | 3.89E-02 | 1.41 |
| TG54:7(18:3) | 11.26 | 0.63±0.08 | 0.25±0.04 | 0.40 | -1.31 | 3.89E-02 | 1.41 |
| TG54:8(18:3) | 10.87 | 0.07±0.01 | 0.03±0.00 | 0.46 | -1.12 | 3.89E-02 | 1.41 |
| TG52:6(18:4) | 11.32 | 0.09±0.02 | 0.02±0.00 | 0.22 | -2.21 | 3.89E-02 | 1.41 |
| TG56:4(20:1) | 12.68 | 0.97±0.17 | 0.29±0.04 | 0.29 | -1.76 | 3.89E-02 | 1.41 |
| TG58:11(20:5) | 11.06 | 0.03±0.01 | 0.15±0.02 | 4.50 | 2.17 | 3.89E-02 | 1.41 |

**Supplementary Table S2.** Distinctly regulated individual lipids (µg/ml, mean ± SEM) in rat plasma following exposure to 10 Gy irradiation at 1 d.

| Differential lipids（10↑, 1↓） | FC | log2(FC) | FDR | -log10(FDR) |
|---|---|---|---|---|
| PC (15:0/22:3) | 2.41 | 1.27 | 2.20E-02 | 1.66 |
| PC (15:0/22:4) | 2.28 | 1.19 | 3.32E-02 | 1.48 |
| PC (O-18:0/20:4) | 2.11 | 1.08 | 2.20E-02 | 1.66 |
| PC (O-18:1/20:4) | 2.04 | 1.03 | 2.20E-02 | 1.66 |
| PC (O-20:0/22:5) | 2.36 | 1.24 | 1.15E-02 | 1.94 |
| SM(d18:2/18:1) | 2.14 | 1.10 | 1.41E-02 | 1.85 |
| SM(d18:2/18:2) | 2.73 | 1.45 | 1.53E-02 | 1.82 |
| SM(d18:3/20:1) | 3.35 | 1.74 | 1.41E-02 | 1.85 |
| SM(d18:3/22:2) | 4.23 | 2.08 | 1.68E-02 | 1.77 |
| TG54:5(18:2) | 0.41 | -1.27 | 4.24E-02 | 1.37 |
| TG60:12(22:6) | 9.75 | 3.29 | 1.41E-02 | 1.85 |

**Supplementary Table S3.** Distinctly regulated individual lipids (µg/ml, mean ± SEM) in rat plasma following exposure to 5 Gy irradiation at 7 d.

| Differential lipids（59↓） | Retention Time(min) | 0 Gy (*n*=5) (µg·ml⁻¹) | 5 Gy (*n*=5) (µg·ml⁻¹) | FC | log2(FC) | FDR | -log10(FDR) |
|---|---|---|---|---|---|---|---|
| DG(16:0/18:2) | 8.10 | 0.09±0.02 | 0.04±0.00 | 0.43 | -1.23 | 4.99E-02 | 1.30 |
| DG(16:0/20:4) | 7.59 | 8.64±1.80 | 2.76±0.36 | 0.32 | -1.65 | 4.94E-02 | 1.31 |
| DG(18:3/18:0) | 8.23 | 8.69±1.59 | 3.25±0.30 | 0.37 | -1.42 | 4.51E-02 | 1.35 |
| PC(15:0/18:0) | 8.39 | 0.11±0.01 | 0.05±0.00 | 0.47 | -1.10 | 1.45E-02 | 1.84 |
| PC(15:0/22:3) | 7.92 | 0.05±0.00 | 0.02±0.00 | 0.46 | -1.11 | 2.27E-02 | 1.64 |
| PC(17:0/22:5) | 7.06 | 0.16±0.02 | 0.08±0.00 | 0.48 | -1.05 | 3.98E-02 | 1.40 |
| PC(O-16:0/16:0) | 7.60 | 0.34±0.02 | 0.14±0.02 | 0.42 | -1.26 | 1.45E-02 | 1.84 |
| PC(O-18:1/20:4) | 7.18 | 2.20±0.16 | 0.96±0.13 | 0.44 | -1.20 | 2.27E-02 | 1.64 |
| PE(18:0/20:3) | 7.87 | 0.07±0.01 | 0.04±0.00 | 0.48 | -1.05 | 2.46E-02 | 1.61 |
| PE(18:0/20:4) | 7.60 | 2.88±0.32 | 1.39±0.13 | 0.48 | -1.05 | 2.46E-02 | 1.61 |
| PE(18:1/20:1) | 8.31 | 0.03±0.00 | 0.01±0.00 | 0.48 | -1.07 | 2.46E-02 | 1.61 |
| PE(O-18:3/20:4) | 6.65 | 1.95±0.14 | 0.89±0.08 | 0.45 | -1.14 | 1.52E-02 | 1.82 |
| PS(16:0/18:0) | 5.85 | 5.49±0.84 | 2.70±0.24 | 0.49 | -1.03 | 4.94E-02 | 1.31 |
| SM(d19:1/20:1) | 7.50 | 0.02±0.00 | 0.01±0.00 | 0.37 | -1.45 | 2.46E-02 | 1.61 |
| TG48:4(18:2) | 11.06 | 0.07±0.01 | 0.03±0.00 | 0.38 | -1.40 | 2.46E-02 | 1.61 |
| TG46:2(18:2) | 11.39 | 0.09±0.01 | 0.04±0.00 | 0.46 | -1.13 | 2.46E-02 | 1.61 |
| TG51:3(18:2) | 12.08 | 1.85±0.21 | 0.72±0.06 | 0.39 | -1.36 | 2.46E-02 | 1.61 |
| TG51:4(18:2) | 11.72 | 1.53±0.17 | 0.54±0.05 | 0.35 | -1.51 | 2.46E-02 | 1.61 |
| TG51:5(18:3) | 11.35 | 0.05±0.01 | 0.02±0.00 | 0.32 | -1.66 | 2.46E-02 | 1.61 |
| TG51:5(18:2) | 11.35 | 0.09±0.01 | 0.02±0.00 | 0.28 | -1.84 | 2.46E-02 | 1.61 |
| TG50:2(18:1) | 12.23 | 9.88±1.49 | 4.67±0.52 | 0.47 | -1.08 | 4.81E-02 | 1.32 |
| TG50:3(18:2) | 11.87 | 8.61±1.12 | 3.46±0.21 | 0.40 | -1.31 | 2.46E-02 | 1.61 |
| TG50:4(18:3) | 11.53 | 0.38±0.05 | 0.15±0.01 | 0.39 | -1.34 | 2.47E-02 | 1.61 |
| TG52:2(18:1) | 12.61 | 46.59±5.402 | 22.51±1.81 | 0.48 | -1.05 | 2.47E-02 | 1.61 |
| TG52:3(18:2) | 12.28 | 69.01±7.60 | 30.52±1.25 | 0.44 | -1.18 | 2.46E-02 | 1.61 |
| TG56:2(22:1) | 13.32 | 0.23±0.04 | 0.08±0.01 | 0.34 | -1.57 | 3.03E-02 | 1.52 |
| TG58:1(24:0) | 13.89 | 0.10±0.010 | 0.04±0.01 | 0.43 | -1.22 | 2.46E-02 | 1.61 |
| TG52:4(18:2) | 11.93 | 65.15±8.11 | 25.68±2.56 | 0.39 | -1.34 | 2.46E-02 | 1.61 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TG52:5(18:3) | 11.57 | 2.97±0.47 | 0.93±0.14 | 0.31 | -1.68 | 2.48E-02 | 1.61 |
| TG56:8(22:6) | 11.64 | 1.81±0.28 | 0.77±0.13 | 0.43 | -1.23 | 4.51E-02 | 1.35 |
| TG48:4(18:2) | 11.44 | 0.33±0.06 | 0.14±0.01 | 0.40 | -1.30 | 4.39E-02 | 1.36 |
| TG52:6(20:4) | 11.21 | 0.22±0.04 | 0.08±0.01 | 0.36 | -1.47 | 4.43E-02 | 1.35 |
| TG53:3(18:2) | 12.47 | 1.41±0.18 | 0.55±0.05 | 0.39 | -1.36 | 2.46E-02 | 1.61 |
| TG53:4(18:2) | 12.13 | 0.59±0.07 | 0.20±0.01 | 0.34 | -1.54 | 2.46E-02 | 1.61 |
| TG53:5(18:2) | 11.79 | 0.35±0.05 | 0.12±0.01 | 0.33 | -1.62 | 2.46E-02 | 1.61 |
| TG55:4(20:4) | 12.71 | 0.01±0.00 | 0.00±0.00 | 0.45 | -1.14 | 4.94E-02 | 1.31 |
| TG54:2(18:1) | 12.97 | 3.20±0.53 | 1.32±0.16 | 0.41 | -1.27 | 4.51E-02 | 1.35 |
| TG54:3(18:2) | 12.66 | 6.44±0.82 | 2.93±0.26 | 0.45 | -1.14 | 2.55E-02 | 1.59 |
| TG56:1(20:0) | 13.55 | 0.04±0.01 | 0.02±0.00 | 0.41 | -1.30 | 4.94E-02 | 1.31 |
| TG54:3(18:1) | 12.66 | 29.46±3.71 | 12.08±0.99 | 0.41 | -1.29 | 2.46E-02 | 1.61 |
| TG54:4(18:2) | 12.34 | 39.04±4.87 | 15.12±1.86 | 0.39 | -1.37 | 2.46E-02 | 1.61 |
| TG55:2(19:0) | 13.12 | 0.11±0.02 | 0.05±0.01 | 0.43 | -1.21 | 4.94E-02 | 1.31 |
| TG55:3(19:1) | 12.85 | 0.28±0.05 | 0.09±0.01 | 0.33 | -1.61 | 2.69E-02 | 1.57 |
| TG58:2(22:0) | 13.62 | 0.21±0.03 | 0.08±0.01 | 0.40 | -1.32 | 2.47E-02 | 1.61 |
| TG58:3(22:1) | 13.35 | 0.23±0.03 | 0.08±0.01 | 0.35 | -1.53 | 2.49E-02 | 1.60 |
| TG60:2(24:0) | 13.94 | 0.12±0.01 | 0.05±0.01 | 0.40 | -1.32 | 2.46E-02 | 1.61 |
| TG60:3(24:1) | 13.69 | 0.20±0.03 | 0.07±0.01 | 0.35 | -1.53 | 2.46E-02 | 1.61 |
| TG54:5(18:2) | 11.99 | 35.47±4.43 | 13.82±2.10 | 0.39 | -1.36 | 2.46E-02 | 1.61 |
| TG54:6(18:3) | 11.64 | 2.68±0.39 | 0.90±0.15 | 0.34 | -1.57 | 2.46E-02 | 1.61 |
| TG55:4(19:1) | 12.51 | 0.33±0.05 | 0.11±0.01 | 0.33 | -1.58 | 2.46E-02 | 1.61 |
| TG58:4(22:1) | 13.03 | 0.21±0.03 | 0.06±0.01 | 0.31 | -1.68 | 2.47E-02 | 1.61 |
| TG60:4(24:1) | 13.35 | 0.16±0.02 | 0.05±0.01 | 0.31 | -1.69 | 2.46E-02 | 1.61 |
| TG54:6(18:2) | 11.63 | 22.57±3.05 | 8.10±1.42 | 0.36 | -1.48 | 2.46E-02 | 1.61 |
| TG54:7(18:3) | 11.26 | 1.27±0.20 | 0.43±0.07 | 0.34 | -1.56 | 2.92E-02 | 1.53 |
| TG54:8(18:3) | 10.87 | 0.12±0.02 | 0.05±0.01 | 0.42 | -1.26 | 2.55E-02 | 1.59 |
| TG52:6(18:4) | 11.32 | 0.16±0.03 | 0.07±0.01 | 0.45 | -1.16 | 4.94E-02 | 1.31 |
| TG56:3(20:1) | 12.99 | 1.21±0.20 | 0.34±0.04 | 0.28 | -1.85 | 2.48E-02 | 1.61 |
| TG56:4(20:1) | 12.68 | 2.11±0.33 | 0.63±0.12 | 0.30 | -1.74 | 2.47E-02 | 1.61 |
| TG60:5(24:1) | 13.08 | 0.13±0.02 | 0.04±0.01 | 0.28 | -1.85 | 2.46E-02 | 1.61 |

**Supplementary Table S4.** Distinctly regulated individual lipids (μg/ml, mean ± SEM) in rat plasma following exposure to 10 Gy irradiation at 7 d.

| Differential lipids (1↑ , 144↓) | FC | log2(FC) | FDR | -log10(FDR) |
|---|---|---|---|---|
| DG(16:0/18:2) | 0.27 | -1.90 | 8.31E-03 | 2.08 |
| DG(16:0/20:4) | 0.13 | -2.93 | 8.26E-03 | 2.08 |
| DG(18:3/18:0) | 0.24 | -2.08 | 8.35E-03 | 2.08 |
| DG(20:3/18:3) | 0.34 | -1.58 | 3.40E-02 | 1.47 |
| DG(20:4/18:2) | 0.45 | -1.16 | 2.38E-02 | 1.62 |
| FA(20:2) | 0.32 | -1.63 | 1.81E-02 | 1.74 |
| FA(20:3) | 0.42 | -1.25 | 2.90E-02 | 1.54 |
| FA(24:1) | 0.48 | -1.05 | 1.66E-02 | 1.78 |
| LysoPC(20:2) | 0.46 | -1.12 | 7.62E-03 | 2.12 |
| LysoPE(17:0) | 0.36 | -1.48 | 5.28E-04 | 3.28 |
| PC(12:0/20:4) | 0.49 | -1.02 | 1.81E-02 | 1.74 |
| PC(14:0/15:0) | 0.29 | -1.81 | 1.06E-03 | 2.97 |
| PC(15:0/18:0) | 0.35 | -1.53 | 5.28E-04 | 3.28 |
| PC(15:0/18:2) | 0.26 | -1.94 | 6.52E-04 | 3.19 |
| PC(15:0/22:3) | 0.45 | -1.16 | 1.81E-03 | 2.74 |
| PC(15:0/22:4) | 0.45 | -1.14 | 3.57E-03 | 2.45 |
| PC(16:0/16:0) | 0.46 | -1.13 | 1.81E-03 | 2.74 |
| PC(16:1/16:1) | 0.35 | -1.53 | 1.32E-02 | 1.88 |
| PC(16:1/20:5) | 0.42 | -1.27 | 2.00E-02 | 1.70 |
| PC(17:0/18:0) | 0.37 | -1.45 | 1.30E-03 | 2.89 |
| PC(17:0/18:1) | 0.47 | -1.10 | 3.24E-03 | 2.49 |
| PC(17:0/18:2) | 0.27 | -1.91 | 7.51E-04 | 3.12 |
| PC(17:0/22:4) | 0.35 | -1.52 | 4.57E-03 | 2.34 |
| PC(17:0/22:5) | 0.35 | -1.52 | 8.26E-03 | 2.08 |
| PC(17:0/22:6) | 0.43 | -1.22 | 3.81E-03 | 2.42 |
| PC(17:1/18:2) | 0.34 | -1.54 | 2.06E-03 | 2.69 |
| PC(18:0/18:3) | 0.49 | -1.04 | 2.41E-03 | 2.62 |
| PC(18:0/20:0) | 0.50 | -1.01 | 6.13E-03 | 2.21 |
| PC(18:0/20:1) | 0.49 | -1.03 | 4.33E-03 | 2.36 |
| PC(18:0/24:1) | 0.35 | -1.50 | 5.28E-04 | 3.28 |
| PC(18:2/24:1) | 0.31 | -1.68 | 5.73E-04 | 3.24 |
| PC(18:3/16:2) | 0.45 | -1.16 | 3.59E-02 | 1.45 |
| PC(19:0/22:6) | 0.29 | -1.77 | 3.85E-03 | 2.41 |
| PC(20:4/22:4) | 0.44 | -1.17 | 2.24E-02 | 1.65 |

| | | | | |
|---|---|---|---|---|
| PC(22:6/24:1) | 0.48 | -1.06 | 1.92E-03 | 2.72 |
| PC(O-16:0/16:0) | 0.27 | -1.90 | 5.28E-04 | 3.28 |
| PC(O-16:0/18:0) | 0.40 | -1.34 | 1.46E-03 | 2.84 |
| PC(O-18:0/22:5) | 0.47 | -1.10 | 4.40E-03 | 2.36 |
| PC(O-18:1/20:4) | 0.44 | -1.20 | 3.21E-03 | 2.49 |
| PE(16:0/18:1) | 0.48 | -1.06 | 2.06E-03 | 2.69 |
| PE(16:0/18:2) | 0.35 | -1.53 | 3.13E-03 | 2.50 |
| PE(17:0/18:2) | 0.23 | -2.15 | 6.51E-04 | 3.19 |
| PE(18:0/18:2) | 0.26 | -1.96 | 1.30E-03 | 2.89 |
| PE(18:0/20:3) | 0.20 | -2.32 | 1.04E-03 | 2.98 |
| PE(18:0/20:4) | 0.23 | -2.09 | 1.61E-03 | 2.79 |
| PE(18:0/22:6) | 0.41 | -1.29 | 3.21E-03 | 2.49 |
| PE(18:1/18:2) | 0.34 | -1.54 | 1.45E-03 | 2.84 |
| PE(18:1/20:1) | 0.24 | -2.08 | 7.18E-04 | 3.14 |
| PE(18:2/18:2) | 0.44 | -1.18 | 8.12E-03 | 2.09 |
| PE(18:2/20:4) | 0.44 | -1.19 | 1.68E-02 | 1.77 |
| PE(O-18:3/20:4) | 0.39 | -1.36 | 1.12E-03 | 2.95 |
| PG(18:2/18:3) | 0.46 | -1.13 | 7.51E-04 | 3.12 |
| PS(16:0/18:0) | 0.31 | -1.71 | 7.50E-03 | 2.12 |
| PS(18:0/18:0) | 0.34 | -1.54 | 4.22E-03 | 2.37 |
| PS(18:1/20:0) | 2.27 | 1.18 | 1.33E-03 | 2.88 |
| PS(18:2/22:1) | 0.47 | -1.10 | 6.51E-04 | 3.19 |
| SM(d16:1/12:0) | 0.08 | -3.64 | 7.51E-04 | 3.12 |
| SM(d18:2/18:2) | 0.47 | -1.09 | 1.32E-02 | 1.88 |
| SM(d18:3/20:1) | 0.47 | -1.10 | 2.47E-02 | 1.61 |
| SM(d19:1/20:1) | 0.29 | -1.80 | 3.57E-03 | 2.45 |
| TG48:4(18:2) | 0.17 | -2.58 | 1.84E-03 | 2.73 |
| TG46:2 (18:2) | 0.23 | -2.12 | 1.81E-03 | 2.74 |
| TG54:8 (22:6) | 0.05 | -4.44 | 2.55E-03 | 2.59 |
| TG51:3 (18:2) | 0.10 | -3.34 | 1.12E-03 | 2.95 |
| TG51:4 (18:2) | 0.09 | -3.54 | 1.04E-03 | 2.98 |
| TG51:5 (18:3) | 0.05 | -4.39 | 1.04E-03 | 2.98 |
| TG53:7 (20:5) | 0.07 | -3.85 | 2.55E-03 | 2.59 |
| TG51:5 (18:2) | 0.06 | -4.17 | 1.81E-03 | 2.74 |
| TG50:4 (20:4) | 0.31 | -1.67 | 8.09E-03 | 2.09 |
| TG49:2 (18:2) | 0.39 | -1.38 | 7.61E-03 | 2.12 |
| TG49:3 (18:2) | 0.33 | -1.59 | 4.10E-03 | 2.39 |
| TG50:1 (18:1) | 0.49 | -1.04 | 3.03E-02 | 1.52 |

| | | | | |
|---|---|---|---|---|
| TG52:4 (20:4) | 0.45 | -1.15 | 3.27E-02 | 1.49 |
| TG52:5 (20:5) | 0.26 | -1.95 | 3.09E-03 | 2.51 |
| TG54:6 (22:6) | 0.22 | -2.16 | 1.96E-02 | 1.71 |
| TG50:2 (18:2) | 0.31 | -1.71 | 4.33E-03 | 2.36 |
| TG50:4 (18:3) | 0.28 | -1.84 | 4.33E-03 | 2.36 |
| TG54:6 (22:6) | 0.12 | -3.03 | 5.43E-03 | 2.27 |
| TG51:1 (18:1) | 0.35 | -1.53 | 2.04E-02 | 1.69 |
| TG52:1 (19:1) | 0.32 | -1.66 | 1.75E-02 | 1.76 |
| TG51:2 (18:1) | 0.33 | -1.62 | 9.70E-03 | 2.01 |
| TG52:2 (18:1) | 0.43 | -1.21 | 6.65E-03 | 2.18 |
| TG52:3 (18:2) | 0.21 | -2.28 | 1.60E-03 | 2.79 |
| TG54:5 (20:4) | 0.40 | -1.31 | 2.59E-02 | 1.59 |
| TG56:2 (22:1) | 0.19 | -2.42 | 4.40E-03 | 2.36 |
| TG56:5 (22:4) | 0.22 | -2.21 | 1.03E-02 | 1.99 |
| TG56:7 (22:6) | 0.14 | -2.84 | 2.52E-03 | 2.60 |
| TG58:1 (24:0) | 0.32 | -1.62 | 3.74E-03 | 2.43 |
| TG52:4 (18:2) | 0.13 | -2.93 | 1.61E-03 | 2.79 |
| TG52:5 (18:3) | 0.07 | -3.78 | 2.55E-03 | 2.59 |
| TG54:6(20:4) | 0.25 | -2.01 | 2.59E-02 | 1.59 |
| TG54:7(20:5) | 0.11 | -3.24 | 7.62E-03 | 2.12 |
| TG56:7(22:5) | 0.05 | -4.33 | 8.07E-03 | 2.09 |
| TG56:8(22:6) | 0.06 | -4.14 | 2.33E-03 | 2.63 |
| TG48:3(18:2) | 0.28 | -1.86 | 8.09E-03 | 2.09 |
| TG52:6(20:4) | 0.22 | -2.19 | 8.07E-03 | 2.09 |
| TG54:8(20:5) | 0.16 | -2.67 | 8.41E-03 | 2.08 |
| TG53:3(18:2) | 0.13 | -2.91 | 1.81E-03 | 2.74 |
| TG55:5(20:4) | 0.25 | -1.99 | 9.62E-03 | 2.02 |
| TG53:4(18:2) | 0.18 | -2.48 | 1.92E-03 | 2.72 |
| TG53:5(18:2) | 0.11 | -3.12 | 1.81E-03 | 2.74 |
| TG50:0(18:0) | 0.44 | -1.17 | 1.19E-02 | 1.92 |
| TG52:1(18:1) | 0.34 | -1.56 | 2.00E-02 | 1.70 |
| TG55:4(20:4) | 0.30 | -1.75 | 6.65E-03 | 2.18 |
| TG54:1(18:1) | 0.39 | -1.36 | 2.28E-02 | 1.64 |
| TG54:2(18:1) | 0.32 | -1.64 | 1.03E-02 | 1.99 |
| TG54:3(18:2) | 0.24 | -2.06 | 2.55E-03 | 2.59 |
| TG56:1(20:0) | 0.31 | -1.68 | 1.06E-02 | 1.98 |
| TG56:5(20:4) | 0.37 | -1.44 | 1.23E-02 | 1.91 |
| TG58:5(22:4) | 0.23 | -2.11 | 1.28E-02 | 1.89 |

| | | | | |
|---|---|---|---|---|
| TG56:6(20:4) | 0.36 | -1.48 | 1.28E-02 | 1.89 |
| TG58:9(20:5) | 0.25 | -2.01 | 4.43E-03 | 2.35 |
| TG54:3(18:1) | 0.37 | -1.44 | 6.23E-03 | 2.21 |
| TG54:4(18:2) | 0.20 | -2.31 | 2.16E-03 | 2.67 |
| TG55:2(19:0) | 0.27 | -1.87 | 8.09E-03 | 2.09 |
| TG55:3(19:1) | 0.20 | -2.35 | 4.59E-03 | 2.34 |
| TG58:2(22:0) | 0.27 | -1.87 | 3.21E-03 | 2.49 |
| TG58:3(22:1) | 0.19 | -2.37 | 3.57E-03 | 2.45 |
| TG58:7(22:5) | 0.32 | -1.66 | 1.20E-02 | 1.92 |
| TG58:8(22:6) | 0.18 | -2.46 | 4.33E-03 | 2.36 |
| TG60:2(24:0) | 0.27 | -1.89 | 2.76E-03 | 2.56 |
| TG60:3(24:1) | 0.18 | -2.48 | 2.76E-03 | 2.56 |
| TG54:5(18:2) | 0.15 | -2.75 | 1.77E-03 | 2.75 |
| TG54:6(18:3) | 0.10 | -3.40 | 2.06E-03 | 2.69 |
| TG55:4(19:1) | 0.17 | -2.53 | 2.55E-03 | 2.59 |
| TG56:7(20:4) | 0.17 | -2.52 | 1.45E-03 | 2.84 |
| TG56:8(20:5) | 0.13 | -2.98 | 7.63E-03 | 2.12 |
| TG58:4(22:1) | 0.14 | -2.85 | 3.09E-03 | 2.51 |
| TG58:8(22:5) | 0.16 | -2.62 | 1.65E-02 | 1.78 |
| TG58:9(22:6) | 0.07 | -3.77 | 4.48E-03 | 2.35 |
| TG60:4(24:1) | 0.14 | -2.85 | 2.41E-03 | 2.62 |
| TG54:6(18:2) | 0.11 | -3.23 | 1.81E-03 | 2.74 |
| TG56:8(20:4) | 0.19 | -2.36 | 2.52E-02 | 1.60 |
| TG58:10(22:6) | 0.08 | -3.72 | 7.27E-03 | 2.14 |
| TG54:7(18:3) | 0.12 | -3.11 | 3.06E-03 | 2.51 |
| TG54:8(18:3) | 0.19 | -2.36 | 2.54E-03 | 2.59 |
| TG56:10(20:5) | 0.07 | -3.78 | 4.40E-03 | 2.36 |
| TG58:10(22:5) | 0.06 | -4.12 | 4.48E-03 | 2.35 |
| TG52:6(18:4) | 0.15 | -2.74 | 3.99E-03 | 2.40 |
| TG60:8(20:4) | 0.31 | -1.69 | 4.22E-02 | 1.37 |
| TG56:3(20:1) | 0.15 | -2.71 | 4.33E-03 | 2.36 |
| TG56:4(20:1) | 0.11 | -3.20 | 2.84E-03 | 2.55 |
| TG58:6(20:4) | 0.35 | -1.52 | 2.38E-02 | 1.62 |
| TG56:9(20:5) | 0.11 | -3.16 | 4.33E-03 | 2.36 |
| TG60:5(24:1) | 0.10 | -3.30 | 2.55E-03 | 2.59 |

**Supplementary Table S5.** Distinctly regulated individual lipids (μg/ml, mean ± SEM) in rat plasma following exposure to 5 Gy irradiation at 14 d.

| Differential lipids（7↑ , 27↓） | Retention Time(min) | 0 Gy (*n*=5) (μg·ml⁻¹) | 5 Gy (*n*=3) (μg·ml⁻¹) | FC | log2(FC) | FDR | -log10(FDR) |
|---|---|---|---|---|---|---|---|
| FA(14:1) | 7.54 | 1.40±0.17 | 0.49±0.12 | 0.42 | -1.24 | 8.71E-02 | 1.06 |
| FA(16:1) | 7.98 | 12.77±2.08 | 2.80±0.32 | 0.24 | -2.07 | 8.76E-02 | 1.06 |
| FA(17:1) | 8.21 | 1.80±0.20 | 0.55±0.15 | 0.37 | -1.42 | 7.53E-02 | 1.12 |
| FA(18:1) | 8.42 | 47.31±4.19 | 14.6±4.68 | 0.38 | -1.39 | 7.42E-02 | 1.13 |
| FA(18:2) | 8.07 | 58.78±4.01 | 19.50±7.42 | 0.42 | -1.25 | 7.13E-02 | 1.15 |
| FA(18:3) | 7.76 | 12.10±1.45 | 1.84±0.58 | 0.16 | -2.62 | 7.13E-02 | 1.15 |
| FA(18:4) | 7.50 | 0.19±0.03 | 0.04±0.01 | 0.22 | -2.16 | 8.34E-02 | 1.08 |
| FA(20:2) | 8.47 | 2.50±0.27 | 0.73±0.33 | 0.35 | -1.50 | 8.48E-02 | 1.07 |
| FA(20:3) | 8.17 | 2.36±0.29 | 0.65±0.24 | 0.33 | -1.61 | 8.48E-02 | 1.07 |
| FA(20:5) | 7.67 | 1.29±0.20 | 0.27±0.03 | 0.22 | -2.16 | 8.48E-02 | 1.07 |
| FA(22:2) | 8.87 | 0.13±0.01 | 0.05±0.02 | 0.47 | -1.08 | 9.43E-02 | 1.03 |
| FA(22:4) | 8.28 | 3.18±0.36 | 1.02±0.34 | 0.39 | -1.36 | 8.48E-02 | 1.07 |
| FA(22:6) | 7.82 | 3.86±0.39 | 1.21±0.38 | 0.38 | -1.38 | 7.53E-02 | 1.12 |
| PA(18:0/20:1) | 8.40 | 0.12±0.00 | 0.04±0.02 | 0.50 | -1.00 | 1.02E-02 | 1.99 |
| PC(12:0/20:4) | 4.96 | 0.03±0.00 | 0.01±0.00 | 0.37 | -1.43 | 9.28E-02 | 1.03 |
| PC(16:1/18:3) | 5.63 | 0.20±0.02 | 0.07±0.02 | 0.40 | -1.33 | 8.48E-02 | 1.07 |
| PC(16:1/20:5) | 5.35 | 0.06±0.01 | 0.02±0.01 | 0.39 | -1.35 | 8.48E-02 | 1.07 |
| PC(18:0/24:1) | 9.67 | 0.01±0.00 | 0.02±0.01 | 2.32 | 1.21 | 8.48E-02 | 1.07 |
| PC(18:1/20:4) | 6.50 | 3.47±0.28 | 1.33±0.42 | 0.48 | -1.05 | 7.53E-02 | 1.12 |
| PC(18:1/22:6) | 6.40 | 1.52±0.15 | 0.57±0.16 | 0.47 | -1.10 | 8.48E-02 | 1.07 |
| PC(18:2/24:1) | 8.97 | 0.03±0.00 | 0.05±0.02 | 2.06 | 1.04 | 7.53E-02 | 1.12 |
| PG(18:2/18:3) | 5.73 | 6.28±0.40 | 11.96±5.15 | 2.52 | 1.33 | 8.48E-02 | 1.07 |
| PS(18:2/22:1) | 5.70 | 11.86±0.45 | 25.38±11.003 | 2.84 | 1.51 | 7.53E-02 | 1.12 |
| SM(d18:0/14:0) | 5.58 | 0.01±0.00 | 0.00±0.00 | 0.33 | -1.58 | 8.48E-02 | 1.07 |
| SM(d18:1/20:0) | 7.98 | 1.77±0.15 | 0.70±0.23 | 0.50 | -1.00 | 7.53E-02 | 1.12 |
| SM(d18:2/18:1) | 5.73 | 0.10±0.01 | 0.03±0.01 | 0.38 | -1.39 | 7.53E-02 | 1.12 |
| SM(d18:2/18:2) | 4.95 | 0.06±0.01 | 0.02±0.00 | 0.38 | -1.41 | 8.48E-02 | 1.07 |
| SM(d18:2/20:0) | 7.35 | 1.08±0.07 | 0.42±0.14 | 0.50 | -1.00 | 6.00E-02 | 1.22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SM(d18:3/20:1) | 6.01 | 0.04±0.00 | 0.01±0.00 | 0.32 | -1.66 | 3.94E-02 | 1.40 |
| SM(d18:3/22:2) | 6.33 | 0.14±0.02 | 0.03±0.00 | 0.22 | -2.21 | 8.48E-02 | 1.07 |
| TG56:5(22:4) | 12.46 | 0.36±0.03 | 1.21±0.60 | 4.47 | 2.16 | 8.76E-02 | 1.06 |
| TG52:1(18:1) | 12.92 | 0.60±0.07 | 0.95±0.38 | 2.05 | 1.04 | 8.60E-02 | 1.07 |
| TG58:11(20:5) | 11.06 | 0.35±0.05 | 0.04±0.01 | 0.12 | -3.10 | 7.53E-02 | 1.12 |
| TG60:5(24:1) | 13.08 | 0.02±0.01 | 0.05±0.02 | 4.32 | 2.11 | 9.28E-02 | 1.03 |

**Supplementary Table S6.** Effects of ionizing radiation on lipids levels with good dose-response (μg/ml, mean ± SEM) in rat plasma at 1 d after exposure.

| Lipid | Retention Time (min) | 0 Gy ($n$=5) ($\mu g \cdot ml^{-1}$) | 5 Gy ($n$=5) ($\mu g \cdot ml^{-1}$) | 10 Gy ($n$=5) ($\mu g \cdot ml^{-1}$) |
|---|---|---|---|---|
| SM(d18:3/20:1) | 6.01 | 0.02±0.00 | 0.04±0.00[*] | 0.06±0.01[*] |
| SM(d18:2/18:2) | 4.95 | 0.02±0.00 | 0.06±0.00[*] | 0.07±0.01[*] |
| TG60:12(22:6) | 11.23 | 0.06±0.01 | 0.35±0.04[*] | 0.55±0.07[*] |
| TG54:5(18:2) | 11.99 | 20.81±2.48 | 7.39±1.17[*] | 8.62±1.41[*] |

*Note.* Compared with 0 Gy, [*] FDR< 0.05

**Supplementary Table S7.** Effects of ionizing radiation on lipids levels with good dose-response (µg/ml, mean ± SEM) in rat plasma at 7 d after exposure.

| Lipid | Retention Time (min) | 0 Gy (*n*=5) (µg·ml⁻¹) | 5 Gy (*n*=5) (µg·ml⁻¹) | 10 Gy (*n*=5) (µg·ml⁻¹) |
|---|---|---|---|---|
| DG(16:0/20:4) | 7.59 | 8.64±1.80 | 2.76±0.36* | 1.13±0.13*,& |
| PE(18:1/20:1) | 8.31 | 0.03±0.00 | 0.01±0.00* | 0.01±0.00*,& |
| PE(18:0/20:3) | 7.87 | 0.07±0.01 | 0.04±0.00* | 0.01±0.00*,& |
| PE(18:0/20:4) | 7.60 | 2.88±0.32 | 1.39±0.13* | 0.68±0.03*,& |
| TG48:4(18:2) | 11.06 | 0.07±0.01 | 0.03±0.00* | 0.01±0.00*,& |
| TG51:3(18:2) | 12.08 | 1.85±0.21 | 0.72±0.06* | 0.18±0.03*,& |
| TG51:4(18:2) | 11.72 | 1.53±0.17 | 0.54±0.05* | 0.13±0.02*,& |
| TG51:5(18:3) | 11.35 | 0.05±0.01 | 0.02±0.00* | 0±0.00*,& |
| TG51:5(18:2) | 11.35 | 0.09±0.01 | 0.02±0.00* | 0±0.00*,& |
| TG52:1(19:1) | 12.92 | 3.40±0.66 | 1.82±0.54* | 1.07±0.14*,& |
| TG52:3(18:2) | 12.28 | 69.01±7.60 | 30.52±1.25* | 14.23±2.12*,& |
| TG52:4(18:2) | 11.93 | 65.15±8.11 | 25.68±2.56* | 8.56±1.32*,& |
| TG52:5(18:3) | 11.57 | 2.97±0.47 | 0.93±0.14* | 0.22±0.03*,& |
| TG52:6(18:4) | 11.32 | 0.16±0.03 | 0.07±0.01* | 0.02±0.00*,& |
| TG53:5(18:2) | 11.79 | 0.35±0.05 | 0.12±0.01* | 0.04±0.01*,& |
| TG54:5(18:2) | 11.99 | 35.47±4.43 | 13.82±2.10* | 5.26±0.65*,& |
| TG54:6(18:3) | 11.64 | 2.68±0.39 | 0.9±0.15* | 0.25±0.03*,& |
| TG54:6(18:2) | 11.63 | 22.57±3.05 | 8.10±1.42* | 2.41±0.30*,& |
| TG54:7(18:3) | 11.26 | 1.27±0.20 | 0.43±0.07* | 0.15±0.01*,& |
| TG54:8(18:3) | 10.87 | 0.12±0.02 | 0.05±0.01* | 0.02±0.00*,& |
| TG56:4(20:1) | 12.68 | 2.11±0.33 | 0.63±0.12* | 0.23±0.04*,& |
| TG56:8(22:6) | 11.64 | 1.81±0.28 | 0.77±0.13* | 0.10±0.02*,& |
| TG58:4(22:1) | 13.03 | 0.21±0.03 | 0.06±0.01* | 0.03±0.00*,& |
| TG60:5(24:1) | 13.08 | 0.13±0.02 | 0.04±0.01* | 0.01±0.00*,& |

**Note.** Compared with 0 Gy, * FDR < 0.05. Compared with 5 Gy, & FDR < 0.05

**Supplementary Table S8.** Effects of ionizing radiation on lipids levels with good dose-response and time-response (µg/ml, mean ± SEM) in rat plasma.

| Lipid | Retention Time(min) | 0 Gy-d1 (*n*=5) | 5 Gy-d1 (*n*=5) | 10 Gy-d1 (*n*=5) | 0 Gy-d7 (*n*=5) | 5 Gy-d7 (*n*=5) | 10 Gy-d7 (*n*=5) | 0 Gy-d14 (*n*=5) | 5 Gy-d14 (*n*=3) |
|---|---|---|---|---|---|---|---|---|---|
| DG(16:0/18:2) | 8.10 | 0.06±0.01 | $0.02\pm0.00^{**}$ | $0.03\pm0.01^{*}$ | 0.09±0.02 | $0.04\pm0.00^{**}$ | $0.02\pm0.00^{***}$ | 0.03±0.00 | 0.03±0.01 |
| DG(18:3/18:0) | 8.23 | 5.31±0.79 | $1.68\pm0.15^{**}$ | $2.92\pm0.57^{*}$ | 8.69±1.59 | $3.25\pm0.30^{**}$ | $2.05\pm0.24^{***}$ | 3.46±0.33 | 3.39±1.13 |
| DG(16:0/20:4) | 7.59 | 4.75±0.53 | $2.26\pm0.20^{*}$ | 4.21±0.76 | 8.64±1.80 | $2.76\pm0.36^{**}$ | $1.13\pm0.13^{***}$ | 5.45±0.57 | 4.27±1.62 |
| FA(20:2) | 8.47 | 1.53±0.25 | 1.24±0.14 | 1.78±0.3 | 1.71±0.32 | 1.22±0.13 | $0.55\pm0.10^{**}$ | 2.5±0.27 | $0.89\pm0.34^{*}$ |
| FA(20:3) | 8.17 | 1.57±0.19 | 1.39±0.17 | 1.91±0.29 | 1.92±0.35 | 1.45±0.16 | $0.81\pm0.12^{*}$ | 2.36±0.29 | $0.77\pm0.23^{*}$ |
| PC(12:0/20:4) | 4.96 | 0.01±0.00 | 0.02±0.00 | $0.03\pm0.01^{**}$ | 0.01±0.00 | 0.01±0.00 | $0.01\pm0.00^{*}$ | 0.03±0.00 | $0.01\pm0.00^{*}$ |
| PC(16:1/20:5) | 5.35 | 0.08±0.01 | 0.04±0.00 | 0.08±0.01 | 0.12±0.02 | $0.07\pm0.01^{*}$ | $0.05\pm0.00^{**}$ | 0.06±0.01 | $0.02\pm0.00^{*}$ |
| PC(15:0/22:3) | 7.92 | 0.04±0.01 | $0.06\pm0.00^{*}$ | $0.09\pm0.01^{***,\&}$ | 0.05±0.00 | $0.02\pm0.00^{***}$ | $0.02\pm0.00^{***}$ | 0.06±0.01 | $0.03\pm0.01^{*}$ |
| PC(15:0/22:4) | 7.61 | 0.29±0.03 | 0.4±0.04 | $0.65\pm0.07^{***,\&}$ | 0.29±0.02 | $0.21\pm0.01^{*}$ | $0.13\pm0.02^{***,\&}$ | 0.33±0.03 | $0.28\pm0.03^{*}$ |
| PC(O-18:1/20:4) | 7.18 | 2.51±0.40 | $3.74\pm0.24^{*}$ | $5.12\pm0.31^{***,\&}$ | 2.2±0.16 | $0.96\pm0.13^{***}$ | $0.96\pm0.16^{***}$ | 2.99±0.21 | $1.57\pm0.37^{*}$ |
| PC(18:0/24:1) | 9.67 | 0.04±0.00 | $0.02\pm0.00^{*}$ | $0.04\pm0.00^{\&}$ | 0.04±0.00 | $0.03\pm0.00^{*}$ | $0.01\pm0.00^{***,\&\&}$ | 0.01±0.00 | $0.03\pm0.01^{*}$ |
| PC(18:2/24:1) | 8.97 | 0.07±0.01 | 0.05±0.00 | 0.08±0.01 | 0.09±0.01 | $0.08\pm0.01^{***}$ | $0.03\pm0.00^{***,\&\&}$ | 0.03±0.00 | $0.07\pm0.01^{*}$ |
| PG(18:2/18:3) | 5.73 | 14.3±1.08 | $9.07\pm0.89^{**}$ | $9.61\pm0.4^{**}$ | 16.08±0.69 | 14.69±1.49 | $7.33\pm0.75^{***,\&\&}$ | 6.28±0.4 | $15.81\pm3.17^{*}$ |
| PS(18:2/22:1) | 5.70 | 32.87±2.58 | $21.04\pm2.2^{**}$ | $22.76\pm1.57^{*}$ | 35.25±1.51 | 36.79±2.75 | $16.41\pm1.27^{***,\&\&}$ | 11.86±0.45 | $33.7\pm6.65^{*}$ |
| SM(d18:2/18:2) | 4.95 | 0.02±0.00 | $0.06\pm0.00^{**}$ | $0.07\pm0.01^{***}$ | 0.02±0.00 | 0.02±0.00 | $0.01\pm0.00^{**,\&}$ | 0.06±0.01 | $0.02\pm0.00^{*}$ |
| SM(d18:3/20:1) | 6.01 | 0.02±0.00 | $0.04\pm0.00^{**}$ | $0.06\pm0.01^{***}$ | 0.02±0.00 | 0.02±0.00 | $0.01\pm0.00^{*}$ | 0.04±0.00 | $0.01\pm0.00^{*}$ |
| TG48:4(18:2) | 11.06 | 0.04±0.01 | $0.01\pm0.00^{**}$ | $0.01\pm0.00^{**}$ | 0.07±0.01 | $0.03\pm0.00^{**}$ | $0.01\pm0.00^{***}$ | 0.03±0.01 | 0.02±0.00 |
| TG51:3(18:2) | 12.08 | 0.88±0.16 | $0.19\pm0.03^{***}$ | $0.31\pm0.06^{**}$ | 1.85±0.21 | $0.72\pm0.06^{**}$ | $0.18\pm0.03^{***,\&}$ | 0.32±0.04 | $0.51\pm0.02^{*}$ |
| TG51:4(18:2) | 11.72 | 0.74±0.11 | $0.22\pm0.04^{**}$ | $0.36\pm0.07^{*}$ | 1.53±0.17 | $0.54\pm0.05^{**}$ | $0.13\pm0.02^{***,\&}$ | 0.42±0.07 | 0.56±0.07 |
| TG51:5(18:2) | 11.35 | 0.04±0.01 | $0.01\pm0.00^{**}$ | $0.02\pm0.00^{*}$ | 0.09±0.01 | $0.02\pm0.00^{**}$ | $0\pm0.00^{***}$ | 0.02±0.00 | 0.03±0.01 |
| TG51:5(18:3) | 11.35 | 0.02±0.00 | $0.01\pm0.00^{**}$ | 0.01±0.00 | 0.05±0.01 | $0.02\pm0.00^{**}$ | $0\pm0.00^{***}$ | 0.01±0.00 | 0.01±0.00 |
| TG52:1(18:1) | 12.92 | 2.26±0.73 | $0.46\pm0.06^{*}$ | $0.56\pm0.07^{*}$ | 3.48±0.67 | 1.91±0.55 | $1.18\pm0.15^{*}$ | 0.6±0.07 | 1.24±0.21 |
| TG52:3(18:2) | 12.28 | 42.3±7.14 | $10.64\pm1.6^{**}$ | $18.01\pm3.15^{**}$ | 69.01±7.6 | $30.52\pm1.25^{***}$ | $14.23\pm2.12^{***}$ | 19.09±2.54 | 22.31±4.39 |
| TG52:4(18:2) | 11.93 | 38.66±4.83 | $13.08\pm1.8^{***}$ | $22.08\pm3.64^{*}$ | 65.15±8.11 | $25.68\pm2.56^{***}$ | $8.56\pm1.32^{***}$ | 27.35±4.33 | 26.61±7.39 |
| TG52:5(18:3) | 11.57 | 1.66±0.26 | $0.51\pm0.08^{**}$ | 0.94±0.2 | 2.97±0.47 | $0.93\pm0.14^{***}$ | $0.22\pm0.03^{***}$ | 1.36±0.27 | 1.06±0.33 |
| TG52:6(18:4) | 11.32 | 0.09±0.02 | $0.02\pm0.00^{**}$ | $0.03\pm0.01^{**}$ | 0.16±0.03 | $0.07\pm0.01^{***}$ | $0.02\pm0.00^{***}$ | 0.17±0.04 | $0.03\pm0.01^{*}$ |
| TG52:6(20:4) | 11.21 | 0.12±0.02 | $0.02\pm0.00^{**}$ | $0.05\pm0.01^{*}$ | 0.22±0.04 | $0.08\pm0.01^{**}$ | $0.05\pm0.01^{***}$ | 0.1±0.03 | 0.04±0.01 |
| TG53:3(18:2) | 12.47 | 0.68±0.11 | $0.19\pm0.03^{**}$ | $0.28\pm0.05^{**}$ | 1.41±0.18 | $0.55\pm0.05^{***}$ | $0.19\pm0.03^{***}$ | 0.26±0.03 | $0.47\pm0.05^{*}$ |
| TG53:4(18:2) | 12.13 | 0.32±0.07 | $0.05\pm0.01^{**}$ | $0.08\pm0.01^{**}$ | 0.59±0.07 | $0.2\pm0.01^{***}$ | $0.11\pm0.02^{***}$ | 0.1±0.02 | 0.11±0.03 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TG53:5(18:2) | 11.79 | 0.19±0.03 | 0.05±0.01** | 0.08±0.01** | 0.35±0.05 | 0.12±0.01*** | 0.04±0.01*** | 0.1±0.02 | 0.09±0.02 |
| TG54:3(18:1) | 12.66 | 17.75±3.76 | 3.6±0.50** | 4.65±0.80** | 29.46±3.71 | 12.08±0.99*** | 10.83±1.80*** | 5.9±0.79 | 8.05±1.35 |
| TG54:3(18:2) | 12.66 | 3.94±0.65 | 1.13±0.18** | 1.53±0.27** | 6.44±0.82 | 2.93±0.26*** | 1.54±0.19*** | 1.74±0.25 | 2.75±0.40 |
| TG54:4(18:2) | 12.34 | 23.07±3.71 | 6.1±0.92** | 7.72±1.34** | 39.04±4.87 | 15.12±1.86*** | 7.89±1.24*** | 11.03±1.59 | 11.34±2.22 |
| TG54:5(18:2) | 11.99 | 20.81±2.48 | 7.39±1.17** | 8.62±1.41** | 35.47±4.43 | 13.82±2.10*** | 5.26±0.65*** | 12.24±2.07 | 12.05±2.66 |
| TG54:6(18:2) | 11.63 | 13.42±1.88 | 4.5±0.80** | 5.04±0.86** | 22.57±3.05 | 8.1±1.42*** | 2.41±0.30*** | 7.78±1.57 | 8.32±2.33 |
| TG54:6(18:3) | 11.64 | 1.5±0.21 | 0.47±0.08** | 0.6±0.12** | 2.68±0.39 | 0.9±0.15*** | 0.25±0.03*** | 0.92±0.18 | 0.85±0.23 |
| TG54:7(18:3) | 11.26 | 0.63±0.08 | 0.25±0.04** | 0.33±0.06* | 1.27±0.20 | 0.43±0.07*** | 0.15±0.01*** | 0.7±0.16 | 0.39±0.10 |
| TG54:7(22:6) | 11.50 | 0.25±0.03 | 0.12±0.01* | 0.23±0.03& | 0.53±0.10 | 0.25±0.03*** | 0.07±0.01*** | 0.55±0.12 | 0.2±0.08 |
| TG54:8(18:3) | 10.87 | 0.07±0.01 | 0.03±0.00** | 0.04±0.01* | 0.12±0.02 | 0.05±0.01*** | 0.02±0.00*** | 0.09±0.02 | 0.04±0.01 |
| TG54:8(20:5) | 11.11 | 0.07±0.01 | 0.02±0.00* | 0.05±0.01 | 0.13±0.03 | 0.06±0.01* | 0.02±0.00** | 0.13±0.04 | 0.03±0.01* |
| TG54:8(22:6) | 11.19 | 0.02±0.00 | 0.01±0.00* | 0.02±0.00 | 0.04±0.01 | 0.02±0.00* | 0±0.00**,& | 0.01±0.00 | 0.01±0.00 |
| TG55:4(19:1) | 12.51 | 0.15±0.03 | 0.03±0.00*** | 0.05±0.01** | 0.33±0.05 | 0.11±0.01*** | 0.06±0.01*** | 0.06±0.01 | 0.08±0.01 |
| TG55:5(20:4) | 12.38 | 0.01±0.00 | 0.01±0.00 | 0.01±0.00 | 0.03±0.01 | 0.02±0.00 | 0.01±0.00** | 0.01±0.00 | 0.02±0.00 |
| TG56:4(20:1) | 12.68 | 0.97±0.17 | 0.29±0.04** | 0.39±0.08** | 2.11±0.33 | 0.63±0.12*** | 0.23±0.04*** | 0.38±0.09 | 0.89±0.22 |
| TG56:5(22:4) | 12.46 | 1.59±0.22 | 0.61±0.11* | 1.08±0.23 | 3.39±0.65 | 1.62±0.17* | 0.73±0.16** | 0.36±0.03 | 1.60±0.48* |

*Note.* Compared with 0 Gy at each time point, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Compared with 5 Gy at each time point, $^*\&< 0.05$, $^{**}\&\& <$

0.01

**Supplementary Table S9.** Classification evaluation indicators for seven machine learning models to distinguish 0 Gy vs. >0 Gy group.

| ML Model | | Sensitivity | Specificity | Accuracy | Precision | Recall | F1 | AUC |
|---|---|---|---|---|---|---|---|---|
| LASSO | train | 1.00 | 0.00 | 0.88 | 0.88 | 1.00 | 0.93 | 0.99 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.95 |
| | validation | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| RF | train | 1.00 | 0.00 | 0.88 | 0.88 | 1.00 | 0.93 | 1.00 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.67 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| SVM | train | 1.00 | 0.00 | 0.88 | 0.88 | 1.00 | 0.93 | 0.90 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.50 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| NN | train | 1.00 | 0.20 | 0.90 | 0.90 | 1.00 | 0.95 | 0.92 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.90 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.58 |
| KNN | train | 1.00 | 0.00 | 0.88 | 0.88 | 1.00 | 0.93 | 0.59 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.67 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| Light GBM | train | 1.00 | 0.00 | 0.88 | 0.88 | 1.00 | 0.93 | 0.50 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.50 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| DT | train | 0.91 | 0.80 | 0.90 | 0.97 | 0.91 | 0.94 | 0.86 |
| | test | 0.86 | 0.67 | 0.80 | 0.86 | 0.86 | 0.86 | 0.76 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |

*Note.* ML, machine learning; LASSO, least absolute shrinkage and selection operator; RF, random forest; SVM, support vector machine; NN, neural network model;

KNN, K-nearest neighbor algorithm; Light GBM, light gradient boosting machine; DT, decision tree; AUC, area under the curve

**Supplementary Table S10.** Classification evaluation indicators for seven machine learning models to distinguish ≤2 Gy vs.>2 Gy group.

| ML Model | | Sensitivity | Specificity | Accuracy | Precision | Recall | F1 | AUC |
|---|---|---|---|---|---|---|---|---|
| LASSO | train | 0.86 | 0.84 | 0.85 | 0.86 | 0.86 | 0.86 | 0.95 |
| | test | 1.00 | 0.80 | 0.90 | 0.83 | 1.00 | 0.91 | 0.92 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.82 |
| RF | train | 1.00 | 0.00 | 0.50 | 0.50 | 1.00 | 0.67 | 1.00 |
| | test | 1.00 | 0.00 | 0.70 | 0.70 | 1.00 | 0.82 | 0.67 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 1.00 |
| SVM | train | 1.00 | 0.00 | 0.53 | 0.53 | 1.00 | 0.69 | 1.00 |
| | test | 1.00 | 0.00 | 0.50 | 0.50 | 1.00 | 0.67 | 0.90 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| NN | train | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | test | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | validation | 0.00 | 1.00 | 0.33 | NA | 0.00 | NA | 0.77 |
| KNN | train | 0.48 | 0.63 | 0.55 | 0.59 | 0.48 | 0.53 | 0.71 |
| | test | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| Light GBM | train | 1.00 | 0.00 | 0.50 | 0.50 | 1.00 | 0.67 | 0.50 |
| | test | 1.00 | 0.00 | 0.53 | 0.53 | 1.00 | 0.69 | 0.50 |
| | validation | 1.00 | 0.00 | 0.67 | 0.67 | 1.00 | 0.80 | 0.50 |
| DT | train | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | test | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | validation | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*Note.* ML, machine learning; LASSO, least absolute shrinkage and selection operator; RF, random forest; SVM, support vector machine; NN, neural network model;

KNN, K-nearest neighbor algorithm; Light GBM, light gradient boosting machine; DT, decision tree; AUC, area under the curve

**Supplementary Table S11.** Classification evaluation indicators for seven machine learning models to distinguish ≤5 Gy vs.>5 Gy group.

| ML Model | | Sensitivity | Specificity | Accuracy | Precision | Recall | F1 | AUC |
|---|---|---|---|---|---|---|---|---|
| LASSO | train | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | test | 0.50 | 1.00 | 0.90 | 1.00 | 0.50 | 0.67 | 1.00 |
| | validation | 1.00 | 0.40 | 0.60 | 0.45 | 1.00 | 0.63 | 0.86 |
| RF | train | 1.00 | 0.00 | 0.18 | 0.18 | 1.00 | 0.30 | 1.00 |
| | test | 1.00 | 0.00 | 0.20 | 0.20 | 1.00 | 0.33 | 1.00 |
| | validation | 1.00 | 0.00 | 0.33 | 0.33 | 1.00 | 0.50 | 0.90 |
| SVM | train | 1.00 | 0.00 | 0.18 | 0.18 | 1.00 | 0.30 | 1.00 |
| | test | 1.00 | 0.00 | 0.20 | 0.20 | 1.00 | 0.33 | 1.00 |
| | validation | 1.00 | 0.00 | 0.33 | 0.33 | 1.00 | 0.50 | 0.50 |
| NN | train | 0.00 | 1.00 | 0.83 | NA | 0.00 | NA | 0.50 |
| | test | 0.00 | 1.00 | 0.80 | NA | 0.00 | NA | 0.50 |
| | validation | 0.00 | 1.00 | 0.67 | NA | 0.00 | NA | 0.50 |
| KNN | train | 0.71 | 1.00 | 0.95 | 1.00 | 0.71 | 0.83 | 0.96 |
| | test | 0.50 | 1.00 | 0.90 | 1.00 | 0.50 | 0.67 | 1.00 |
| | validation | 1.00 | 0.00 | 0.33 | 0.33 | 1.00 | 0.50 | 0.50 |
| Light GBM | train | 0.00 | 1.00 | 0.83 | NA | 0.00 | NA | 0.50 |
| | test | 0.00 | 1.00 | 0.80 | NA | 0.00 | NA | 0.50 |
| | validation | 0.00 | 1.00 | 0.67 | NA | 0.00 | NA | 0.50 |
| DT | train | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | test | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | validation | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*Note.* ML, machine learning; LASSO, least absolute shrinkage and selection operator; RF, random forest; SVM, support vector machine; NN, neural network model; KNN, K-nearest neighbor algorithm; Light GBM, light gradient boosting machine; DT, decision tree; AUC, area under the curve