

Associations between saturated fatty acids from different dietary sources and cardiovascular disease risk in 114,285 UK Biobank study participants

R.K. Kelly¹, T.Y.N. Tong¹, M. Guasch-Ferre², K. Papier¹, C. Piernas³, G.K. Fensom¹, J.L. Carter¹, T.J. Key¹, A. Perez-Cornago¹

¹University of Oxford, Nuffield Department of Population Health, Oxford, United Kingdom; ²Harvard T. H. Chan School of Public Health, Department of Nutrition, Boston, United States of America; ³University of Oxford, Nuffield Department of Primary Care Health Sciences, Oxford, United Kingdom

Funding Acknowledgement: Type of funding sources: Public Institution(s). Main funding source(s): Clarendon Fund and Jesus College Clarendon Old Members' Award/Jesus College Graduate Scholarship

Background: Previous studies suggest that different foods rich in saturated fatty acids (SFA), particularly meat and dairy, have diverging directions of association with risks of total cardiovascular disease (CVD) and CVD subtypes.^(1,2)

Purpose: To investigate the associations between SFA from different dietary sources and risks of total CVD, ischaemic heart disease (IHD), and stroke.

Methods: We analysed data on 114,285 UK Biobank participants who had completed ≥ 24 -h dietary assessments and were free of CVD at the date of the latest 24-h dietary assessment. Risks of incident (non-fatal and fatal) total CVD, IHD and stroke by intakes of SFA from different sources were estimated using multivariable Cox regressions. Additional models assessed the role of body mass index (BMI) and low-density lipoprotein cholesterol (LDL-C) as potential mediators. We also estimated the associations between modelled isoenenergetic substitution of 5% energy from SFA from meat with SFA from dairy, polyunsaturated fatty acids, monounsaturated fatty acids, carbohydrates from whole grains and carbohydrates from fruit and vegetables, and risk of CVD outcomes. A false discovery rate controlling procedure was used to account for multiple testing.

Results: Over a median 8.5 years of follow-up, there were 4,365, 3,394, and 1,041 cases of total CVD, IHD and stroke, respectively. There were no significant associations between total SFA intake and CVD outcomes.

SFA from meat was positively associated with total CVD (hazard ratio for each 5% of energy, 1.19; 95% CI, 1.05–1.35) and IHD (1.21; 1.05–1.39) risk independently of lifestyle and cardiovascular risk factors. However, the estimates were attenuated and non-significant for both total CVD (1.11; 0.98–1.26) and IHD (1.12; 0.97–1.29) after adjustment for BMI. SFA from dairy was inversely associated with IHD risk (0.89; 0.82–0.96) in the multivariable model, however this finding was also attenuated after adjustment for BMI and did not pass correction for multiple testing (0.91; 0.84 to 0.98). Modelled replacement of 5% of energy from SFA from meat with carbohydrates from whole grains or carbohydrates from fruit and vegetables were associated with lower risk of stroke in the multivariable model (0.86; 0.78–0.94 & 0.86; 0.78–0.95, respectively) and the model adjusted for BMI and LDL-C (0.87; 0.79–0.96 & 0.86; 0.78–0.95, respectively).

Conclusion(s): SFA from meat was associated with a higher risk of total CVD and IHD, while SFA from dairy was associated with lower risk of IHD, although BMI seemed to account for a large proportion of these associations. It is possible that diverging associations of SFA from different sources with CVD risk may explain the overall null association with total SFA observed in this study and some previous observational studies. Randomised controlled trials are needed to confirm whether replacing SFA from meat by carbohydrate from wholegrains or fruit and vegetables may be beneficial in reducing stroke risk.

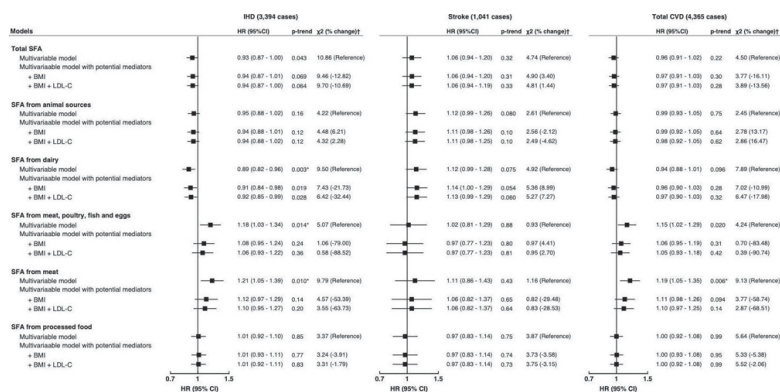


Figure 1. Hazard ratios and 95% CI of IHD, stroke and total CVD for each 5% of energy from sources of SFA in 114,285 UK Biobank participants. All models were stratified by age at recruitment (<40, 40–49, 50–59, 60–69, 70–79 years) and sex. Multivariable models included nonoverlapping region (London, North-West England, North-East England, Yorkshire & the Humber, West Midlands, East Midlands, South-West England, Scotland & Wales), ethnicity (white, mixed race, Asian or Asian British, black or black British, other, unknown), Townsend deprivation index (quintiles from least to most affluent, unknown), qualifications (college/university degrees or vocational qualifications, national examination at ages 17–19 years, national examination at 19 years, national examination at 21 years, 113 unclassified, 103 unclassified, 103 unclassified, 103 unclassified, 103 unclassified), physical activity (low, medium or high according to MET hours per week, unknown), alcohol (non-specific quintiles, unknown), menopausal status (pre-menopausal, post-menopausal, unknown), daily energy intake (quintiles of kJ), free sugar intake (quintiles of daily energy intake), fruit and vegetable intake (quintiles of g/d) and fibre intake (quintiles of g/d). Potential mediators included BMI (25.25–25.49, 25.5–25.99, 26.0–26.49, 26.5–26.99, 27.0–27.49, 27.5–27.99, 28.0–28.49, 28.5–28.99, 29.0–29.49, 29.5–29.99, 30.0–30.49, 30.5–30.99, 31.0–31.49, 31.5–31.99, 32.0–32.49, 32.5–32.99, 33.0–33.49, 33.5–33.99, 34.0–34.49, 34.5–34.99, 35.0–35.49, 35.5–35.99, 36.0–36.49, 36.5–36.99, 37.0–37.49, 37.5–37.99, 38.0–38.49, 38.5–38.99, 39.0–39.49, 39.5–39.99, 40.0–40.49, 40.5–40.99, 41.0–41.49, 41.5–41.99, 42.0–42.49, 42.5–42.99, 43.0–43.49, 43.5–43.99, 44.0–44.49, 44.5–44.99, 45.0–45.49, 45.5–45.99, 46.0–46.49, 46.5–46.99, 47.0–47.49, 47.5–47.99, 48.0–48.49, 48.5–48.99, 49.0–49.49, 49.5–49.99, 50.0–50.49, 50.5–50.99, 51.0–51.49, 51.5–51.99, 52.0–52.49, 52.5–52.99, 53.0–53.49, 53.5–53.99, 54.0–54.49, 54.5–54.99, 55.0–55.49, 55.5–55.99, 56.0–56.49, 56.5–56.99, 57.0–57.49, 57.5–57.99, 58.0–58.49, 58.5–58.99, 59.0–59.49, 59.5–59.99, 60.0–60.49, 60.5–60.99, 61.0–61.49, 61.5–61.99, 62.0–62.49, 62.5–62.99, 63.0–63.49, 63.5–63.99, 64.0–64.49, 64.5–64.99, 65.0–65.49, 65.5–65.99, 66.0–66.49, 66.5–66.99, 67.0–67.49, 67.5–67.99, 68.0–68.49, 68.5–68.99, 69.0–69.49, 69.5–69.99, 70.0–70.49, 70.5–70.99, 71.0–71.49, 71.5–71.99, 72.0–72.49, 72.5–72.99, 73.0–73.49, 73.5–73.99, 74.0–74.49, 74.5–74.99, 75.0–75.49, 75.5–75.99, 76.0–76.49, 76.5–76.99, 77.0–77.49, 77.5–77.99, 78.0–78.49, 78.5–78.99, 79.0–79.49, 79.5–79.99, 80.0–80.49, 80.5–80.99, 81.0–81.49, 81.5–81.99, 82.0–82.49, 82.5–82.99, 83.0–83.49, 83.5–83.99, 84.0–84.49, 84.5–84.99, 85.0–85.49, 85.5–85.99, 86.0–86.49, 86.5–86.99, 87.0–87.49, 87.5–87.99, 88.0–88.49, 88.5–88.99, 89.0–89.49, 89.5–89.99, 90.0–90.49, 90.5–90.99, 91.0–91.49, 91.5–91.99, 92.0–92.49, 92.5–92.99, 93.0–93.49, 93.5–93.99, 94.0–94.49, 94.5–94.99, 95.0–95.49, 95.5–95.99, 96.0–96.49, 96.5–96.99, 97.0–97.49, 97.5–97.99, 98.0–98.49, 98.5–98.99, 99.0–99.49, 99.5–99.99, 100.0–100.49, 100.5–100.99, 101.0–101.49, 101.5–101.99, 102.0–102.49, 102.5–102.99, 103.0–103.49, 103.5–103.99, 104.0–104.49, 104.5–104.99, 105.0–105.49, 105.5–105.99, 106.0–106.49, 106.5–106.99, 107.0–107.49, 107.5–107.99, 108.0–108.49, 108.5–108.99, 109.0–109.49, 109.5–109.99, 110.0–110.49, 110.5–110.99, 111.0–111.49, 111.5–111.99, 112.0–112.49, 112.5–112.99, 113.0–113.49, 113.5–113.99, 114.0–114.49, 114.5–114.99, 115.0–115.49, 115.5–115.99, 116.0–116.49, 116.5–116.99, 117.0–117.49, 117.5–117.99, 118.0–118.49, 118.5–118.99, 119.0–119.49, 119.5–119.99, 120.0–120.49, 120.5–120.99, 121.0–121.49, 121.5–121.99, 122.0–122.49, 122.5–122.99, 123.0–123.49, 123.5–123.99, 124.0–124.49, 124.5–124.99, 125.0–125.49, 125.5–125.99, 126.0–126.49, 126.5–126.99, 127.0–127.49, 127.5–127.99, 128.0–128.49, 128.5–128.99, 129.0–129.49, 129.5–129.99, 130.0–130.49, 130.5–130.99, 131.0–131.49, 131.5–131.99, 132.0–132.49, 132.5–132.99, 133.0–133.49, 133.5–133.99, 134.0–134.49, 134.5–134.99, 135.0–135.49, 135.5–135.99, 136.0–136.49, 136.5–136.99, 137.0–137.49, 137.5–137.99, 138.0–138.49, 138.5–138.99, 139.0–139.49, 139.5–139.99, 140.0–140.49, 140.5–140.99, 141.0–141.49, 141.5–141.99, 142.0–142.49, 142.5–142.99, 143.0–143.49, 143.5–143.99, 144.0–144.49, 144.5–144.99, 145.0–145.49, 145.5–145.99, 146.0–146.49, 146.5–146.99, 147.0–147.49, 147.5–147.99, 148.0–148.49, 148.5–148.99, 149.0–149.49, 149.5–149.99, 150.0–150.49, 150.5–150.99, 151.0–151.49, 151.5–151.99, 152.0–152.49, 152.5–152.99, 153.0–153.49, 153.5–153.99, 154.0–154.49, 154.5–154.99, 155.0–155.49, 155.5–155.99, 156.0–156.49, 156.5–156.99, 157.0–157.49, 157.5–157.99, 158.0–158.49, 158.5–158.99, 159.0–159.49, 159.5–159.99, 160.0–160.49, 160.5–160.99, 161.0–161.49, 161.5–161.99, 162.0–162.49, 162.5–162.99, 163.0–163.49, 163.5–163.99, 164.0–164.49, 164.5–164.99, 165.0–165.49, 165.5–165.99, 166.0–166.49, 166.5–166.99, 167.0–167.49, 167.5–167.99, 168.0–168.49, 168.5–168.99, 169.0–169.49, 169.5–169.99, 170.0–170.49, 170.5–170.99, 171.0–171.49, 171.5–171.99, 172.0–172.49, 172.5–172.99, 173.0–173.49, 173.5–173.99, 174.0–174.49, 174.5–174.99, 175.0–175.49, 175.5–175.99, 176.0–176.49, 176.5–176.99, 177.0–177.49, 177.5–177.99, 178.0–178.49, 178.5–178.99, 179.0–179.49, 179.5–179.99, 180.0–180.49, 180.5–180.99, 181.0–181.49, 181.5–181.99, 182.0–182.49, 182.5–182.99, 183.0–183.49, 183.5–183.99, 184.0–184.49, 184.5–184.99, 185.0–185.49, 185.5–185.99, 186.0–186.49, 186.5–186.99, 187.0–187.49, 187.5–187.99, 188.0–188.49, 188.5–188.99, 189.0–189.49, 189.5–189.99, 190.0–190.49, 190.5–190.99, 191.0–191.49, 191.5–191.99, 192.0–192.49, 192.5–192.99, 193.0–193.49, 193.5–193.99, 194.0–194.49, 194.5–194.99, 195.0–195.49, 195.5–195.99, 196.0–196.49, 196.5–196.99, 197.0–197.49, 197.5–197.99, 198.0–198.49, 198.5–198.99, 199.0–199.49, 199.5–199.99, 200.0–200.49, 200.5–200.99, 201.0–201.49, 201.5–201.99, 202.0–202.49, 202.5–202.99, 203.0–203.49, 203.5–203.99, 204.0–204.49, 204.5–204.99, 205.0–205.49, 205.5–205.99, 206.0–206.49, 206.5–206.99, 207.0–207.49, 207.5–207.99, 208.0–208.49, 208.5–208.99, 209.0–209.49, 209.5–209.99, 210.0–210.49, 210.5–210.99, 211.0–211.49, 211.5–211.99, 212.0–212.49, 212.5–212.99, 213.0–213.49, 213.5–213.99, 214.0–214.49, 214.5–214.99, 215.0–215.49, 215.5–215.99, 216.0–216.49, 216.5–216.99, 217.0–217.49, 217.5–217.99, 218.0–218.49, 218.5–218.99, 219.0–219.49, 219.5–219.99, 220.0–220.49, 220.5–220.99, 221.0–221.49, 221.5–221.99, 222.0–222.49, 222.5–222.99, 223.0–223.49, 223.5–223.99, 224.0–224.49, 224.5–224.99, 225.0–225.49, 225.5–225.99, 226.0–226.49, 226.5–226.99, 227.0–227.49, 227.5–227.99, 228.0–228.49, 228.5–228.99, 229.0–229.49, 229.5–229.99, 230.0–230.49, 230.5–230.99, 231.0–231.49, 231.5–231.99, 232.0–232.49, 232.5–232.99, 233.0–233.49, 233.5–233.99, 234.0–234.49, 234.5–234.99, 235.0–235.49, 235.5–235.99, 236.0–236.49, 236.5–236.99, 237.0–237.49, 237.5–237.99, 238.0–238.49, 238.5–238.99, 239.0–239.49, 239.5–239.99, 240.0–240.49, 240.5–240.99, 241.0–241.49, 241.5–241.99, 242.0–242.49, 242.5–242.99, 243.0–243.49, 243.5–243.99, 244.0–244.49, 244.5–244.99, 245.0–245.49, 245.5–245.99, 246.0–246.49, 246.5–246.99, 247.0–247.49, 247.5–247.99, 248.0–248.49, 248.5–248.99, 249.0–249.49, 249.5–249.99, 250.0–250.49, 250.5–250.99, 251.0–251.49, 251.5–251.99, 252.0–252.49, 252.5–252.99, 253.0–253.49, 253.5–253.99, 254.0–254.49, 254.5–254.99, 255.0–255.49, 255.5–255.99, 256.0–256.49, 256.5–256.99, 257.0–257.49, 257.5–257.99, 258.0–258.49, 258.5–258.99, 259.0–259.49, 259.5–259.99, 260.0–260.49, 260.5–260.99, 261.0–261.49, 261.5–261.99, 262.0–262.49, 262.5–262.99, 263.0–263.49, 263.5–263.99, 264.0–264.49, 264.5–264.99, 265.0–265.49, 265.5–265.99, 266.0–266.49, 266.5–266.99, 267.0–267.49, 267.5–267.99, 268.0–268.49, 268.5–268.99, 269.0–269.49, 269.5–269.99, 270.0–270.49, 270.5–270.99, 271.0–271.49, 271.5–271.99, 272.0–272.49, 272.5–272.99, 273.0–273.49, 273.5–273.99, 274.0–274.49, 274.5–274.99, 275.0–275.49, 275.5–275.99, 276.0–276.49, 276.5–276.99, 277.0–277.49, 277.5–277.99, 278.0–278.49, 278.5–278.99, 279.0–279.49, 279.5–279.99, 280.0–280.49, 280.5–280.99, 281.0–281.49, 281.5–281.99, 282.0–282.49, 282.5–282.99, 283.0–283.49, 283.5–283.99, 284.0–284.49, 284.5–284.99, 285.0–285.49, 285.5–285.99, 286.0–286.49, 286.5–286.99, 287.0–287.49, 287.5–287.99, 288.0–288.49, 288.5–288.99, 289.0–289.49, 289.5–289.99, 290.0–290.49, 290.5–290.99, 291.0–291.49, 291.5–291.99, 292.0–292.49, 292.5–292.99, 293.0–293.49, 293.5–293.99, 294.0–294.49, 294.5–294.99, 295.0–295.49, 295.5–295.99, 296.0–296.49, 296.5–296.99, 297.0–297.49, 297.5–297.99, 298.0–298.49, 298.5–298.99, 299.0–299.49, 299.5–299.99, 300.0–300.49, 300.5–300.99, 301.0–301.49, 301.5–301.99, 302.0–302.49, 302.5–302.99, 303.0–303.49, 303.5–303.99, 304.0–304.49, 304.5–304.99, 305.0–305.49, 305.5–305.99, 306.0–306.49, 306.5–306.99, 307.0–307.49, 307.5–307.99, 308.0–308.49, 308.5–308.99, 309.0–309.49, 309.5–309.99, 310.0–310.49, 310.5–310.99, 311.0–311.49, 311.5–311.99, 312.0–312.49, 312.5–312.99, 313.0–313.49, 313.5–313.99, 314.0–314.49, 314.5–314.99, 315.0–315.49, 315.5–315.99, 316.0–316.49, 316.5–316.99, 317.0–317.49, 317.5–317.99, 318.0–318.49, 318.5–318.99, 319.0–319.49, 319.5–319.99, 320.0–320.49, 320.5–320.99, 321.0–321.49, 321.5–321.99, 322.0–322.49, 322.5–322.99, 323.0–323.49, 323.5–323.99, 324.0–324.49, 324.5–324.99, 325.0–325.49, 325.5–325.99, 326.0–326.49, 326.5–326.99, 327.0–327.49, 327.5–327.99, 328.0–328.49, 328.5–328.99, 329.0–329.49, 329.5–329.99, 330.0–330.49, 330.5–330.99, 331.0–331.49, 331.5–331.99, 332.0–332.49, 332.5–332.99, 333.0–333.49, 333.5–333.99, 334.0–334.49, 334.5–334.99, 335.0–335.49, 335.5–335.99, 336.0–336.49, 336.5–336.99, 337.0–337.49, 337.5–337.99, 338.0–338.49, 338.5–338.99, 339.0–339.49, 339.5–339.99, 340.0–340.49, 340.5–340.99, 341.0–341.49, 341.5–341.99, 342.0–342.49, 342.5–342.99, 343.0–343.49, 343.5–343.99, 344.0–344.49, 344.5–344.99, 345.0–345.49, 345.5–345.99, 346.0–346.49, 346.5–346.99, 347.0–347.49, 347.5–347.99, 348.0–348.49, 348.5–348.99, 349.0–349.49, 349.5–349.99, 350.0–350.49, 350.5–350.99, 351.0–351.49, 351.5–351.99, 352.0–352.49, 352.5–352.99, 353.0–353.49, 353.5–353.99, 354.0–354.49, 354.5–354.99, 355.0–355.49, 355.5–355.99, 356.0–356.49, 356.5–356.99, 357.0–357.49, 357.5–357.99, 358.0–358.49, 358.5–358.99, 359.0–359.49, 359.5–359.99, 360.0–360.49, 360.5–360.99, 361.0–361.49, 361.5–361.99, 362.0–362.49, 362.5–362.99, 363.0–363.49, 363.5–363.99, 364.0–364.49, 364.5–364.99, 365.0–365.49, 365.5–365.99, 366.0–366.49, 366.5–366.99, 367.0–367.49, 367.5–367.99, 368.0–368.49, 368.5–368.99, 369.0–369.49, 369.5–369.99, 370.0–370.49, 370.5–370.99, 371.0–371.49, 371.5–371.99, 372.0–372.49, 372.5–372.99, 373.0–373.49, 373.5–373.99, 374.0–374.49, 374.5–374.99, 375.0–375.49, 375.5–375.99, 376.0–376.49, 376.5–376.99, 377.0–377.49, 377.5–377.99, 378.0–378.49, 378.5–378.99, 379.0–379.49, 379.5–379.99, 380.0–380.49, 380.5–380.99, 381.0–381.49, 381.5–381.99, 382.0–382.49, 382.5–382.99, 383.0–383.49, 383.5–383.99, 384.0–384.49, 384.5–384.99, 385.0–385.49, 385.5–385.99, 386.0–386.49, 386.5–386.99, 387.0–387.49, 387.5–387.99, 388.0–388.49, 388.5–388.99, 389.0–389.49, 389.5–389.99, 390.0–390.49, 390.5–390.99, 391.0–391.49, 391.5–391.99, 392.0–392.49, 392.5–392.99, 393.0–393.49, 393.5–393.99, 394.0–394.49, 394.5–394.99, 395.0–395.49, 395.5–395.99, 396.0–396.49, 396.5–396.99, 397.0–397.49, 397.5–397.99, 398.0–398.49, 398.5–398.99, 399.0–399.49, 399.5–399.99, 400.0–400.49, 400.5–400.99, 401.0–401.49, 401.5–401.99, 402.0–402.49