**Supplemental** **Table 1**. Adjusted mean (95% CI) intakes of dietary choline and betaine among men stratified by age groups in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 217.6 (212.6, 222.7) | 232.6 (227.4, 237.7) | 249.3 (244.3, 254.2) | 249.9 (245.1, 254.7) | 243.6 (238.5, 248.8) | 252.1 (246.8, 257.5) | 265.9 (260.6, 271.1) | 277.3 (272.4, 282.1) | <0.001 |  |
| 50-65 years | 227.7 (218.7, 236.7) | 227.9 (218.8, 237.0) | 248.3 (239.7, 256.9) | 243.9 (236.0, 251.8) | 233.5 (226.2, 240.9) | 245.7 (238.4, 253.0) | 252.5 (245.3, 259.7) | 264.6 (258.0, 271.2) | <0.001 |  |
| >65 years | 216.2 (203.0, 229.5) | 229.2 (216.2, 242.2) | 245.8 (234.3, 257.4) | 244.8 (233.8, 255.8) | 235.5 (225.7, 245.2) | 235.1 (225.5, 244.7) | 240.9 (231.6, 250.2) | 246.0 (237.7, 254.2) | 0.006 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | 0.786 |
| 18-50 years | 89.0 (87.2, 90.9) | 91.7 (89.8, 93.6) | 95.3 (93.5, 97.1) | 96.0 (94.2, 97.7) | 93.5 (91.6, 95.4) | 94.1 (92.1, 96.0) | 96.6 (94.7, 98.5) | 100.6 (98.8, 102.3) | <0.001 |  |
| 50-65 years | 89.2 (85.9, 92.4) | 90.8 (87.5, 94.1) | 93.1 (90.0, 96.2) | 93.4 (90.5, 96.3) | 88.8 (86.1, 91.5) | 89.4 (86.7, 92.0) | 92.2 (89.6, 94.8) | 93.9 (91.5, 96.3) | 0.122 |  |
| >65 years | 84.5 (79.7, 89.3) | 81.0 (76.2, 85.7) | 89.3 (85.0, 93.5) | 87.4 (83.4, 91.4) | 86.1 (82.5, 89.6) | 87.4 (83.9, 90.9) | 87.7 (84.3, 91.1) | 89.0 (86.0, 92.0) | 0.033 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | 0.651 |
| 18-50 years | 56.3 (54.9, 57.6) | 57.7 (56.3, 59.0) | 61.1 (59.7, 62.4) | 61.3 (60.0, 62.6) | 58.9 (57.5, 60.3) | 59.0 (57.5, 60.4) | 60.8 (59.4, 62.3) | 63.3 (61.9, 64.6) | <0.001 |  |
| 50-65 years | 56.6 (54.2, 59.0) | 57.5 (55.1, 59.9) | 60.8 (58.5, 63.1) | 60.0 (57.9, 62.1) | 55.8 (53.9, 57.8) | 55.4 (53.5, 57.4) | 58.6 (56.7, 60.5) | 58.8 (57.1, 60.6) | 0.771 |  |
| >65 years | 54.2 (50.8, 57.6) | 50.5 (47.2, 53.9) | 56.8 (53.8, 59.7) | 55.5 (52.7, 58.3) | 54.4 (52.0, 56.9) | 53.6 (51.1, 56.1) | 55.0 (52.7, 57.4) | 55.5 (53.4, 57.6) | 0.301 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.359 |
| 18-50 years | 6.6 (6.3, 6.9) | 7.2 (6.9, 7.4) | 7.5 (7.3, 7.8) | 7.7 (7.4, 7.9) | 7.6 (7.3, 7.9) | 7.8 (7.5, 8.1) | 8.5 (8.2, 8.8) | 9.6 (9.4, 9.9) | <0.001 |  |
| 50-65 years | 6.9 (6.4, 7.4) | 7.5 (7.0, 8.0) | 7.6 (7.1, 8.0) | 7.8 (7.4, 8.2) | 7.6 (7.2, 8.0) | 7.9 (7.5, 8.3) | 8.5 (8.1, 8.8) | 9.0 (8.6, 9.3) | <0.001 |  |
| >65 years | 6.9 (6.1, 7.6) | 6.9 (6.2, 7.6) | 7.3 (6.7, 7.9) | 7.6 (7.0, 8.2) | 7.7 (7.2, 8.3) | 8.1 (7.6, 8.7) | 8.3 (7.8, 8.8) | 8.9 (8.5, 9.4) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.249 |
| 18-50 years | 26.2 (25.6, 26.8) | 26.8 (26.2, 27.5) | 26.6 (26.0, 27.2) | 27.0 (26.4, 27.6) | 27.0 (26.4, 27.7) | 27.3 (26.6, 27.9) | 27.3 (26.6, 27.9) | 27.7 (27.1, 28.3) | <0.001 |  |
| 50-65 years | 25.6 (24.6, 26.7) | 25.6 (24.5, 26.7) | 24.6 (23.6, 25.6) | 25.6 (24.6, 26.5) | 25.4 (24.5, 26.2) | 26.1 (25.2, 26.9) | 25.1 (24.3, 26.0) | 26.0 (25.2, 26.8) | 0.428 |  |
| >65 years | 23.3 (21.5, 25.0) | 23.5 (21.8, 25.2) | 25.3 (23.7, 26.8) | 24.2 (22.8, 25.7) | 23.9 (22.6, 25.2) | 25.6 (24.3, 26.9) | 24.5 (23.2, 25.7) | 24.6 (23.5, 25.6) | 0.232 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 129.4 (125.1, 133.7) | 141.5 (137.2, 145.8) | 154.8 (150.6, 159.0) | 154.6 (150.5, 158.7) | 150.8 (146.4, 155.1) | 158.8 (154.3, 163.3) | 170.0 (165.5, 174.4) | 177.7 (173.6, 181.7) | <0.001 |  |
| 50-65 years | 139.5 (131.8, 147.1) | 137.9 (130.1, 145.7) | 156.0 (148.7, 163.3) | 151.0 (144.3, 157.8) | 145.2 (138.9, 151.5) | 157.1 (150.9, 163.3) | 160.9 (154.8, 167.0) | 171.7 (166.1, 177.3) | <0.001 |  |
| >65 years | 132.7 (121.3, 144.1) | 149.2 (138.0, 160.4) | 157.6 (147.7, 167.5) | 158.5 (149.1, 168.0) | 150.3 (141.9, 158.7) | 148.8 (140.5, 157.0) | 154.1 (146.1, 162.0) | 158.0 (150.8, 165.1) | 0.022 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 121.1 (117.0, 125.1) | 132.2 (128.2, 136.3) | 145.3 (141.4, 149.3) | 145.0 (141.1, 148.8) | 141.3 (137.2, 145.4) | 148.7 (144.5, 153.0) | 159.1 (154.9, 163.3) | 166.3 (162.5, 170.2) | <0.001 |  |
| 50-65 years | 131.0 (123.7, 138.2) | 129.4 (122.0, 136.7) | 147.1 (140.1, 154.0) | 141.9 (135.5, 148.3) | 136.2 (130.2, 142.1) | 147.4 (141.5, 153.3) | 151.0 (145.2, 156.8) | 161.1 (155.8, 166.4) | <0.001 |  |
| >65 years | 124.9 (114.0, 135.7) | 140.1 (129.5, 150.7) | 148.5 (139.0, 157.9) | 149.1 (140.1, 158.1) | 141.7 (133.7, 149.6) | 139.9 (132.0, 147.7) | 144.9 (137.3, 152.5) | 148.6 (141.9, 155.4) | 0.023 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 8.3 (8.0, 8.6) | 9.3 (9.0, 9.6) | 9.5 (9.2, 9.8) | 9.7 (9.4, 9.9) | 9.5 (9.2, 9.8) | 10.1 (9.8, 10.4) | 10.9 (10.5, 11.2) | 11.3 (11.1, 11.6) | <0.001 |  |
| 50-65 years | 8.5 (8.0, 9.0) | 8.5 (8.0, 9.0) | 9.0 (8.5, 9.4) | 9.1 (8.7, 9.5) | 9.0 (8.6, 9.4) | 9.7 (9.3, 10.1) | 10.0 (9.6, 10.4) | 10.6 (10.3, 11.0) | <0.001 |  |
| >65 years | 7.8 (7.1, 8.5) | 9.1 (8.5, 9.8) | 9.1 (8.5, 9.7) | 9.4 (8.8, 10) | 8.6 (8.1, 9.2) | 8.9 (8.4, 9.4) | 9.2 (8.7, 9.7) | 9.3 (8.9, 9.8) | 0.028 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | 0.485 |
| 18-50 years | 150.4 (145.5, 155.4) | 149.2 (144.3, 154.1) | 159.4 (154.7, 164.1) | 144.3 (139.7, 148.8) | 140.2 (135.4, 144.9) | 144.1 (139.2, 149.0) | 142.7 (137.7, 147.6) | 153.5 (148.8, 158.2) | 0.077 |  |
| 50-65 years | 144.4 (136.6, 152.3) | 141.5 (133.7, 149.4) | 145.4 (138.2, 152.7) | 134.7 (128.0, 141.4) | 127.2 (120.9, 133.5) | 129.0 (122.8, 135.3) | 126.7 (120.5, 132.9) | 136.8 (130.9, 142.6) | 0.004 |  |
| >65 years | 135.6 (125.4, 145.8) | 117.1 (107.3, 127.0) | 125.2 (116.5, 133.9) | 118.0 (109.8, 126.3) | 111.5 (104.1, 118.8) | 116.4 (109.2, 123.7) | 118.4 (111.3, 125.5) | 120.0 (113.5, 126.4) | 0.114 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** **Table 2**. Adjusted mean (95% CI) intakes of dietary choline and betaine among women stratified by age groups in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 191.8 (187.2, 196.4) | 204.1 (199.5, 208.7) | 216.2 (211.7, 220.7) | 218.8 (214.5, 223.1) | 215.3 (210.7, 219.8) | 224.2 (219.6, 228.8) | 237.4 (232.8, 242.1) | 244.4 (240.2, 248.5) | <0.001 |  |
| 50-65 years | 199.1 (190.2, 208.0) | 203.6 (194.7, 212.4) | 226.2 (217.7, 234.7) | 221.4 (213.4, 229.5) | 215.9 (208.4, 223.4) | 220.7 (213.4, 228.0) | 230.1 (222.9, 237.4) | 240.3 (233.6, 247.1) | <0.001 |  |
| >65 years | 200.6 (188.1, 213.1) | 206.4 (193.8, 219.1) | 218.7 (206.7, 230.7) | 218.7 (207.3, 230.0) | 214.9 (204.4, 225.5) | 213.3 (202.9, 223.7) | 217.3 (207.0, 227.7) | 223.7 (214.4, 233.1) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | 0.008 |
| 18-50 years | 79.2 (77.6, 80.8) | 81.7 (80.1, 83.3) | 81.4 (79.8, 83.0) | 83.2 (81.7, 84.8) | 81.0 (79.3, 82.6) | 81.5 (79.8, 83.1) | 84.9 (83.3, 86.6) | 87.7 (86.3, 89.2) | <0.001 |  |
| 50-65 years | 78.5 (75.3, 81.8) | 79.8 (76.6, 83.0) | 86.3 (83.2, 89.4) | 85.1 (82.1, 88.0) | 83.2 (80.5, 86.0) | 81.4 (78.8, 84.1) | 84.6 (82.0, 87.3) | 86.7 (84.3, 89.2) | <0.001 |  |
| >65 years | 74.0 (69.6, 78.4) | 74.1 (69.7, 78.6) | 79.5 (75.3, 83.7) | 74.7 (70.7, 78.7) | 76.0 (72.3, 79.7) | 75.9 (72.3, 79.6) | 78.0 (74.4, 81.7) | 79.0 (75.8, 82.3) | 0.010 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | 0.003 |
| 18-50 years | 50.1 (48.9, 51.3) | 51.6 (50.4, 52.8) | 52.4 (51.2, 53.6) | 53.0 (51.9, 54.2) | 50.8 (49.6, 52.0) | 50.7 (49.5, 51.9) | 53.7 (52.5, 54.9) | 55.6 (54.5, 56.7) | <0.001 |  |
| 50-65 years | 49.4 (47.0, 51.8) | 50.0 (47.6, 52.3) | 55.9 (53.6, 58.2) | 54.7 (52.6, 56.9) | 52.2 (50.2, 54.2) | 50.2 (48.2, 52.1) | 53.5 (51.5, 55.4) | 54.4 (52.6, 56.2) | 0.008 |  |
| >65 years | 47.0 (43.9, 50.2) | 46.5 (43.3, 49.7) | 50.9 (47.9, 53.9) | 47.0 (44.2, 49.9) | 47.3 (44.6, 49.9) | 46.6 (43.9, 49.2) | 48.7 (46.1, 51.3) | 48.9 (46.5, 51.2) | 0.270 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.024 |
| 18-50 years | 6.3 (6.1, 6.5) | 6.7 (6.5, 7.0) | 6.7 (6.4, 6.9) | 6.9 (6.6, 7.1) | 7.0 (6.8, 7.2) | 7.4 (7.1, 7.6) | 7.9 (7.7, 8.2) | 8.6 (8.4, 8.8) | <0.001 |  |
| 50-65 years | 6.5 (6.0, 7.0) | 6.9 (6.4, 7.4) | 7.7 (7.2, 8.2) | 7.7 (7.2, 8.2) | 7.7 (7.2, 8.1) | 7.8 (7.4, 8.2) | 8.2 (7.8, 8.7) | 8.8 (8.4, 9.2) | <0.001 |  |
| >65 years | 6.6 (5.9, 7.3) | 7.0 (6.2, 7.7) | 7.4 (6.7, 8.0) | 6.6 (6, 7.3) | 7.0 (6.4, 7.6) | 7.5 (6.9, 8.1) | 7.7 (7.1, 8.3) | 8.3 (7.7, 8.8) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.546 |
| 18-50 years | 22.9 (22.4, 23.4) | 23.4 (22.9, 23.9) | 22.4 (21.9, 22.8) | 23.4 (22.9, 23.9) | 23.2 (22.7, 23.7) | 23.4 (22.9, 23.9) | 23.3 (22.8, 23.8) | 23.6 (23.1, 24.0) | 0.028 |  |
| 50-65 years | 22.6 (21.6, 23.7) | 22.9 (21.9, 24.0) | 22.7 (21.8, 23.7) | 22.7 (21.7, 23.6) | 23.5 (22.6, 24.3) | 23.4 (22.6, 24.3) | 23.0 (22.2, 23.8) | 23.6 (22.8, 24.4) | 0.044 |  |
| >65 years | 20.3 (18.9, 21.7) | 20.7 (19.2, 22.1) | 21.1 (19.7, 22.5) | 21.0 (19.7, 22.3) | 21.7 (20.5, 22.9) | 21.8 (20.6, 23.0) | 21.6 (20.4, 22.8) | 21.9 (20.8, 22.9) | 0.006 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 113.3 (109.4, 117.3) | 123.0 (119.1, 127.0) | 135.6 (131.7, 139.5) | 136.3 (132.6, 140.0) | 135.0 (131.0, 138.9) | 143.5 (139.5, 147.5) | 153.3 (149.3, 157.3) | 157.6 (154.0, 161.1) | <0.001 |  |
| 50-65 years | 121.3 (113.7, 128.9) | 124.5 (116.9, 132.1) | 140.8 (133.5, 148.0) | 137.0 (130.1, 143.9) | 133.1 (126.7, 139.5) | 139.9 (133.6, 146.2) | 146.0 (139.8, 152.1) | 154.4 (148.7, 160.2) | <0.001 |  |
| >65 years | 127.6 (116.6, 138.6) | 133.4 (122.3, 144.4) | 140.4 (129.9, 150.9) | 145.2 (135.2, 155.1) | 139.9 (130.6, 149.2) | 138.3 (129.1, 147.4) | 140.1 (131.0, 149.2) | 145.7 (137.5, 153.9) | 0.005 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 106.2 (102.5, 110.0) | 115.1 (111.4, 118.9) | 127.5 (123.8, 131.1) | 127.9 (124.4, 131.5) | 126.6 (122.9, 130.3) | 134.7 (130.9, 138.5) | 143.9 (140.1, 147.7) | 148.0 (144.6, 151.4) | <0.001 |  |
| 50-65 years | 113.8 (106.6, 121.0) | 116.7 (109.6, 123.9) | 132.6 (125.7, 139.5) | 128.8 (122.2, 135.3) | 125.0 (118.9, 131.1) | 131.2 (125.3, 137.2) | 137.1 (131.2, 143.0) | 145.1 (139.7, 150.6) | <0.001 |  |
| >65 years | 120.1 (109.7, 130.6) | 125.4 (114.9, 135.9) | 132.5 (122.5, 142.5) | 136.9 (127.4, 146.4) | 132.1 (123.2, 140.9) | 130.2 (121.5, 138.9) | 131.8 (123.1, 140.4) | 137.2 (129.4, 145.0) | 0.006 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| 18-50 years | 7.1 (6.8, 7.3) | 7.9 (7.6, 8.1) | 8.2 (7.9, 8.4) | 8.4 (8.1, 8.6) | 8.3 (8.1, 8.6) | 8.8 (8.6, 9.1) | 9.4 (9.1, 9.7) | 9.6 (9.4, 9.9) | <0.001 |  |
| 50-65 years | 7.5 (7.0, 8.0) | 7.7 (7.3, 8.2) | 8.1 (7.7, 8.6) | 8.2 (7.8, 8.7) | 8.1 (7.7, 8.5) | 8.7 (8.3, 9.1) | 8.9 (8.5, 9.3) | 9.3 (9.0, 9.7) | <0.001 |  |
| >65 years | 7.5 (6.8, 8.1) | 8.0 (7.3, 8.6) | 7.9 (7.3, 8.5) | 8.2 (7.6, 8.8) | 7.8 (7.3, 8.4) | 8.1 (7.5, 8.6) | 8.3 (7.7, 8.8) | 8.5 (8.0, 9.0) | 0.002 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | 0.700 |
| 18-50 years | 123.2 (118.7, 127.7) | 121.5 (117.0, 125.9) | 128.9 (124.7, 133.2) | 118.5 (114.5, 122.6) | 116.0 (111.8, 120.2) | 120.1 (115.8, 124.4) | 121.1 (116.7, 125.4) | 130.2 (126.1, 134.2) | 0.554 |  |
| 50-65 years | 119.2 (111.0, 127.4) | 114.5 (106.4, 122.6) | 121.3 (113.6, 129.0) | 112.0 (104.7, 119.4) | 105.6 (98.7, 112.4) | 110.0 (103.3, 116.7) | 106.7 (100.0, 113.4) | 115.9 (109.7, 122.2) | 0.083 |  |
| >65 years | 113.2 (103.2, 123.2) | 106.3 (96.3, 116.3) | 113.0 (103.5, 122.5) | 105.0 (96.0, 113.9) | 97.9 (89.5, 106.3) | 100.1 (91.9, 108.4) | 101.5 (93.3, 109.8) | 103.5 (96.0, 111.0) | 0.020 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** **Table 3**. Adjusted mean intakes (95% CI) of dietary choline and betaine intake among men stratified by BMI in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.012 |
| <18.5 kg/m2 | 212.0 (199.5, 224.5) | 219.8 (206.5, 233.1) | 228.3 (215.0, 241.5) | 241.4 (227.5, 255.2) | 233.6 (219.2, 248.0) | 231.8 (217.2, 246.5) | 244.8 (230.7, 258.8) | 258.3 (244.0, 272.6) | <0.001 |  |
| 18.5-23.9 kg/m2 | 219.7 (215.0, 224.3) | 228.8 (224.1, 233.4) | 245.8 (241.2, 250.4) | 247.3 (242.8, 251.9) | 240.4 (235.6, 245.1) | 243.6 (238.8, 248.4) | 258.8 (253.9, 263.7) | 264.4 (259.8, 268.9) | <0.001 |  |
| 24.0-27.9 kg/m2 | 217.8 (207.1, 228.5) | 245.4 (235.5, 255.3) | 260.3 (251.7, 268.9) | 250.2 (243.0, 257.5) | 243.9 (237.1, 250.7) | 261.5 (254.7, 268.2) | 261.1 (254.7, 267.5) | 281.6 (276.2, 287.1) | <0.001 |  |
| ≥28.0 kg/m2 | 235.0 (211.5, 258.4) | 233.8 (208.2, 259.4) | 265.2 (247.8, 282.6) | 256.0 (241.3, 270.7) | 241.1 (227.3, 254.8) | 257.5 (243.9, 271.2) | 276.3 (264.1, 288.6) | 276.5 (267.0, 286.1) | <0.001 |  |
| **Water-soluble choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.006 |
| <18.5 kg/m2 | 85.5 (80.5, 90.5) | 89.1 (83.8, 94.4) | 91.6 (86.3, 96.9) | 95.5 (90, 101.1) | 94.8 (89, 100.5) | 88.1 (82.2, 94.0) | 93.2 (87.5, 98.8) | 94.8 (89.1, 100.5) | 0.011 |  |
| 18.5-23.9 kg/m2 | 90.1 (88.4, 91.9) | 91.5 (89.8, 93.3) | 94.6 (92.9, 96.4) | 95.9 (94.1, 97.6) | 92.5 (90.7, 94.3) | 91.9 (90.1, 93.8) | 95.2 (93.3, 97.0) | 96.9 (95.1, 98.6) | <0.001 |  |
| 24.0-27.9 kg/m2 | 85.9 (82.3, 89.5) | 89.1 (85.7, 92.4) | 94.0 (91.1, 96.9) | 91.5 (89.0, 93.9) | 89.1 (86.8, 91.4) | 91.8 (89.6, 94.1) | 92.7 (90.5, 94.8) | 97.9 (96.1, 99.7) | <0.001 |  |
| ≥28.0 kg/m2 | 84.7 (77.6, 91.7) | 84.3 (76.6, 92.0) | 90.6 (85.4, 95.9) | 87.5 (83.1, 91.9) | 83.9 (79.8, 88.0) | 92.8 (88.7, 96.9) | 94.8 (91.1, 98.5) | 93.2 (90.3, 96.0) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | 0.007 |
| <18.5 kg/m2 | 53.9 (50.1, 57.7) | 55.7 (51.7, 59.7) | 59.0 (55.0, 63.0) | 61.8 (57.6, 66.0) | 59.8 (55.5, 64.2) | 55.7 (51.3, 60.1) | 58.6 (54.3, 62.8) | 59.0 (54.7, 63.3) | 0.058 |  |
| 18.5-23.9 kg/m2 | 57.3 (56.0, 58.6) | 57.8 (56.5, 59.1) | 61.1 (59.8, 62.4) | 62.0 (60.7, 63.3) | 58.5 (57.2, 59.9) | 57.3 (56.0, 58.8) | 60.6 (59.2, 62.0) | 61.5 (60.2, 62.8) | 0.002 |  |
| 24.0-27.9 kg/m2 | 57.3 (56.0, 58.6) | 57.8 (56.5, 59.1) | 61.1 (59.8, 62.4) | 62.0 (60.7, 63.3) | 58.5 (57.2, 59.9) | 57.3 (56.0, 58.8) | 60.6 (59.2, 62.0) | 61.5 (60.2, 62.8) | 0.007 |  |
| ≥28.0 kg/m2 | 54.6 (49.7, 59.4) | 54.2 (48.8, 59.5) | 58.4 (54.8, 62.0) | 55.3 (52.2, 58.3) | 52.5 (49.6, 55.3) | 58.2 (55.3, 61.0) | 59.8 (57.3, 62.4) | 57.8 (55.8, 59.7) | 0.028 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.047 |
| <18.5 kg/m2 | 6.9 (6.3, 7.6) | 7.2 (6.5, 7.9) | 7.2 (6.6, 7.9) | 7.6 (6.9, 8.3) | 8.4 (7.7, 9.2) | 7.9 (7.1, 8.6) | 9.1 (8.3, 9.8) | 9.5 (8.8, 10.2) | <0.001 |  |
| 18.5-23.9 kg/m2 | 6.8 (6.6, 7.1) | 7.4 (7.1, 7.7) | 7.6 (7.3, 7.9) | 7.8 (7.5, 8.0) | 7.8 (7.6, 8.1) | 7.9 (7.7, 8.2) | 8.6 (8.3, 8.8) | 9.3 (9.1, 9.6) | <0.001 |  |
| 24.0-27.9 kg/m2 | 6.4 (5.7, 7.0) | 7.2 (6.6, 7.7) | 7.9 (7.4, 8.4) | 7.9 (7.5, 8.3) | 7.4 (7.0, 7.8) | 8.1 (7.7, 8.5) | 8.4 (8.0, 8.8) | 9.6 (9.2, 9.9) | <0.001 |  |
| ≥28.0 kg/m2 | 6.3 (5.3, 7.2) | 5.8 (4.8, 6.9) | 7.0 (6.3, 7.8) | 7.1 (6.5, 7.7) | 7.0 (6.5, 7.6) | 7.9 (7.4, 8.5) | 8.5 (8.0, 9.0) | 8.4 (8.0, 8.8) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.087 |
| <18.5 kg/m2 | 24.6 (23.2, 26.1) | 26.2 (24.7, 27.8) | 25.3 (23.8, 26.8) | 26.1 (24.5, 27.7) | 26.5 (24.8, 28.2) | 24.5 (22.8, 26.2) | 25.7 (24.0, 27.3) | 26.4 (24.7, 28.0) | 0.345 |  |
| 18.5-23.9 kg/m2 | 26.0 (25.4, 26.6) | 26.3 (25.7, 26.9) | 25.8 (25.2, 26.4) | 26.1 (25.6, 26.7) | 26.1 (25.5, 26.7) | 26.7 (26.1, 27.3) | 26.0 (25.4, 26.6) | 26.1 (25.5, 26.6) | 0.709 |  |
| 24.0-27.9 kg/m2 | 24.1 (22.9, 25.3) | 25.0 (23.8, 26.1) | 25.7 (24.7, 26.6) | 26.0 (25.1, 26.8) | 25.8 (25.0, 26.6) | 26.7 (26.0, 27.5) | 26.2 (25.5, 26.9) | 27.4 (26.8, 28.1) | <0.001 |  |
| ≥28.0 kg/m2 | 24.3 (21.7, 27.0) | 24.8 (21.8, 27.7) | 25.7 (23.7, 27.7) | 25.3 (23.6, 27.0) | 24.6 (23.0, 26.2) | 26.7 (25.1, 28.3) | 26.5 (25.1, 27.9) | 26.9 (25.8, 28.0) | 0.015 |  |
| **Lipid-soluble choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.038 |
| <18.5 kg/m2 | 127.0 (116.7, 137.3) | 131.3 (120.3, 142.3) | 137.3 (126.4, 148.3) | 146.1 (134.7, 157.6) | 139.2 (127.3, 151.1) | 144.2 (132.1, 156.3) | 151.8 (140.2, 163.5) | 164.4 (152.6, 176.1) | <0.001 |  |
| 18.5-23.9 kg/m2 | 130.5 (126.6, 134.3) | 138.1 (134.2, 142.0) | 152.2 (148.4, 156.1) | 152.3 (148.5, 156.1) | 148.5 (144.6, 152.5) | 152.5 (148.5, 156.5) | 164.3 (160.2, 168.4) | 168.5 (164.7, 172.3) | <0.001 |  |
| 24.0-27.9 kg/m2 | 133.0 (123.6, 142.3) | 157.1 (148.4, 165.8) | 167.0 (159.5, 174.6) | 159.6 (153.2, 166.0) | 155.6 (149.6, 161.6) | 170.6 (164.7, 176.5) | 169.2 (163.7, 174.8) | 184.8 (180.0, 189.6) | <0.001 |  |
| ≥28.0 kg/m2 | 150.4 (129.6, 171.1) | 149.5 (126.9, 172.2) | 174.6 (159.2, 189.9) | 169.3 (156.3, 182.3) | 157.8 (145.7, 170.0) | 166.0 (153.9, 178.1) | 182.7 (171.8, 193.5) | 184.8 (176.3, 193.2) | <0.001 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.037 |
| <18.5 kg/m2 | 119.3 (109.6, 129.1) | 123.1 (112.7, 133.5) | 129.4 (119.0, 139.8) | 137.4 (126.6, 148.3) | 130.8 (119.6, 142.1) | 135.3 (123.9, 146.8) | 142.5 (131.5, 153.5) | 154.2 (143.1, 165.4) | <0.001 |  |
| 18.5-23.9 kg/m2 | 122.4 (118.7, 126.0) | 129.3 (125.6, 133.0) | 143.3 (139.6, 146.9) | 143.1 (139.5, 146.7) | 139.5 (135.7, 143.2) | 143.0 (139.2, 146.8) | 154.2 (150.3, 158.1) | 158.1 (154.5, 161.7) | <0.001 |  |
| 24.0-27.9 kg/m2 | 125.0 (116.1, 133.8) | 147.2 (139.0, 155.4) | 156.9 (149.8, 164.0) | 149.6 (143.5, 155.6) | 145.9 (140.2, 151.6) | 160.0 (154.4, 165.6) | 158.4 (153.1, 163.7) | 173.1 (168.6, 177.7) | <0.001 |  |
| ≥28.0 kg/m2 | 140.6 (121.0, 160.2) | 139.5 (118.1, 161.0) | 163.8 (149.3, 178.4) | 158.5 (146.2, 170.8) | 147.7 (136.2, 159.2) | 155.4 (143.9, 166.8) | 171.3 (161.0, 181.6) | 172.8 (164.8, 180.8) | <0.001 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | 0.151 |
| <18.5 kg/m2 | 7.7 (7.0, 8.4) | 8.2 (7.5, 9.0) | 8.0 (7.2, 8.7) | 8.7 (7.9, 9.5) | 8.4 (7.6, 9.2) | 8.9 (8.1, 9.8) | 9.3 (8.5, 10.1) | 10.2 (9.3, 11.0) | <0.001 |  |
| 18.5-23.9 kg/m2 | 8.1 (7.8, 8.4) | 8.7 (8.5, 9.0) | 9.0 (8.7, 9.3) | 9.2 (8.9, 9.4) | 9.1 (8.8, 9.4) | 9.5 (9.2, 9.8) | 10.2 (9.9, 10.5) | 10.4 (10.2, 10.7) | <0.001 |  |
| 24.0-27.9 kg/m2 | 8.0 (7.4, 8.6) | 9.9 (9.3, 10.5) | 10.1 (9.7, 10.6) | 10.1 (9.6, 10.5) | 9.7 (9.3, 10.1) | 10.6 (10.2, 11.0) | 10.8 (10.5, 11.2) | 11.7 (11.4, 12.0) | <0.001 |  |
| ≥28.0 kg/m2 | 9.9 (8.5, 11.2) | 10.1 (8.6, 11.5) | 10.8 (9.7, 11.8) | 10.7 (9.9, 11.6) | 10.1 (9.3, 10.9) | 10.6 (9.8, 11.4) | 11.4 (10.7, 12.1) | 12.0 (11.4, 12.5) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| <18.5 kg/m2 | 131.8 (120.3, 143.3) | 128.5 (116.4, 140.6) | 137.3 (125.3, 149.3) | 135.6 (123.2, 148.1) | 129.7 (116.8, 142.5) | 123.0 (109.9, 136.0) | 124.4 (111.8, 137.1) | 140.4 (127.5, 153.4) | 0.873 |  |
| 18.5-23.9 kg/m2 | 143.8 (139.5, 148.2) | 143.3 (139.0, 147.6) | 154.9 (150.7, 159.1) | 144.4 (140.2, 148.5) | 135.6 (131.3, 139.9) | 142.2 (137.8, 146.5) | 141.1 (136.6, 145.6) | 150.3 (146.1, 154.6) | 0.625 |  |
| 24.0-27.9 kg/m2 | 173.3 (164.2, 182.4) | 155.1 (146.7, 163.5) | 156.0 (148.7, 163.2) | 133.8 (127.6, 139.9) | 137.2 (131.4, 143.0) | 138.8 (133.1, 144.5) | 135.5 (130.0, 140.9) | 146.4 (141.6, 151.2) | <0.001 |  |
| ≥28.0 kg/m2 | 180.6 (160.2, 200.9) | 169.5 (147.7, 191.3) | 164.9 (149.9, 180.0) | 147.6 (134.8, 160.3) | 137.8 (125.9, 149.7) | 141.5 (129.7, 153.3) | 146.6 (135.8, 157.4) | 147.2 (138.6, 155.8) | 0.005 |  |

1 Adjusted for age, urbanization index, total energy intake, education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** **Table 4**. Adjusted mean intakes (95% CI) of dietary choline and betaine intake among women stratified by BMI in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.035 |
| <18.5 kg/m2 | 188.7 (178.3, 199.2) | 193.8 (182.8, 204.8) | 197.1 (186.0, 208.3) | 206.9 (195.5, 218.2) | 206.8 (195.5, 218.0) | 204.2 (192.5, 215.9) | 217.9 (206.9, 229.0) | 232.3 (222.0, 242.7) | <0.001 |  |
| 18.5-23.9 kg/m2 | 191.6 (187.1, 196.0) | 201.4 (197.0, 205.9) | 214.4 (210.0, 218.8) | 217.2 (213.0, 221.4) | 213.6 (209.4, 217.9) | 219.7 (215.4, 223.9) | 232.2 (227.9, 236.5) | 236.6 (232.7, 240.4) | <0.001 |  |
| 24.0-27.9 kg/m2 | 198.2 (189.9, 206.5) | 210.6 (202.6, 218.7) | 233.3 (225.8, 240.9) | 223.6 (216.8, 230.5) | 220.1 (213.4, 226.7) | 226.3 (219.7, 232.9) | 230.9 (224.4, 237.3) | 245.9 (240.3, 251.5) | <0.001 |  |
| ≥28.0 kg/m2 | 219.2 (200.9, 237.6) | 217.4 (199.0, 235.8) | 232.5 (216.8, 248.2) | 228.7 (215.3, 242.1) | 221.4 (208.9, 233.9) | 230.5 (218.1, 243.0) | 241.2 (229.2, 253.1) | 249.0 (239.0, 259.0) | <0.001 |  |
| **Water-soluble choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.217 |
| <18.5 kg/m2 | 71.3 (67.5, 75.1) | 73.2 (69.2, 77.2) | 75.3 (71.2, 79.4) | 77.6 (73.4, 81.8) | 79.7 (75.5, 83.8) | 72.7 (68.4, 77.0) | 77.2 (73.1, 81.3) | 81.7 (77.9, 85.5) | <0.001 |  |
| 18.5-23.9 kg/m2 | 78.9 (77.2, 80.5) | 80.2 (78.6, 81.9) | 81.5 (79.8, 83.1) | 83.1 (81.5, 84.7) | 80.8 (79.2, 82.3) | 80.4 (78.8, 81.9) | 84.6 (83.0, 86.2) | 86.4 (84.9, 87.8) | <0.001 |  |
| 24.0-27.9 kg/m2 | 76.9 (74.2, 79.7) | 81.1 (78.4, 83.8) | 83.9 (81.4, 86.4) | 81.2 (79.0, 83.5) | 79.9 (77.7, 82.1) | 80.8 (78.6, 83.0) | 81.6 (79.5, 83.8) | 85.5 (83.6, 87.3) | <0.001 |  |
| ≥28.0 kg/m2 | 80.2 (74.4, 86.0) | 81.0 (75.1, 86.8) | 84.6 (79.6, 89.6) | 80.6 (76.4, 84.9) | 79.4 (75.5, 83.4) | 81.1 (77.2, 85.0) | 83.9 (80.1, 87.6) | 84.9 (81.8, 88.1) | 0.066 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | 0.274 |
| <18.5 kg/m2 | 44.0 (41.1, 46.9) | 45.3 (42.3, 48.4) | 48.5 (45.4, 51.6) | 49.7 (46.5, 52.9) | 49.8 (46.6, 52.9) | 44.5 (41.2, 47.7) | 48.3 (45.2, 51.4) | 51.4 (48.5, 54.3) | 0.002 |  |
| 18.5-23.9 kg/m2 | 50.0 (48.8, 51.2) | 50.7 (49.5, 52.0) | 52.7 (51.5, 53.9) | 53.3 (52.1, 54.5) | 50.7 (49.5, 51.9) | 49.9 (48.7, 51.0) | 53.5 (52.3, 54.7) | 54.4 (53.3, 55.4) | <0.001 |  |
| 24.0-27.9 kg/m2 | 48.8 (46.8, 50.8) | 51.0 (49.1, 52.9) | 53.8 (52.0, 55.6) | 51.2 (49.6, 52.9) | 49.9 (48.3, 51.5) | 49.9 (48.3, 51.5) | 51.5 (50.0, 53.1) | 53.5 (52.1, 54.8) | 0.026 |  |
| ≥28.0 kg/m2 | 51.5 (47.3, 55.7) | 50.8 (46.6, 55.0) | 53.8 (50.2, 57.4) | 50.5 (47.4, 53.5) | 49.0 (46.2, 51.8) | 50.1 (47.3, 52.9) | 51.7 (49.0, 54.4) | 53.0 (50.7, 55.2) | 0.452 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.141 |
| <18.5 kg/m2 | 5.6 (5.1, 6.1) | 6.0 (5.5, 6.6) | 6.1 (5.5, 6.6) | 6.1 (5.6, 6.7) | 6.8 (6.2, 7.3) | 6.7 (6.1, 7.2) | 7.5 (6.9, 8.0) | 8.4 (7.9, 8.9) | <0.001 |  |
| 18.5-23.9 kg/m2 | 6.4 (6.1, 6.6) | 6.7 (6.5, 7.0) | 6.8 (6.6, 7.0) | 6.9 (6.7, 7.2) | 7.1 (6.9, 7.4) | 7.4 (7.2, 7.7) | 8.1 (7.8, 8.3) | 8.6 (8.4, 8.8) | <0.001 |  |
| 24.0-27.9 kg/m2 | 6.2 (5.7, 6.6) | 6.8 (6.3, 7.2) | 7.4 (7.0, 7.8) | 7.1 (6.7, 7.5) | 7.1 (6.7, 7.4) | 7.5 (7.2, 7.9) | 7.6 (7.2, 7.9) | 8.5 (8.2, 8.8) | <0.001 |  |
| ≥28.0 kg/m2 | 6.5 (5.5, 7.5) | 6.7 (5.8, 7.7) | 7.0 (6.1, 7.8) | 7.1 (6.4, 7.8) | 7.0 (6.3, 7.6) | 7.6 (6.9, 8.3) | 8.1 (7.4, 8.7) | 8.1 (7.6, 8.6) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.436 |
| <18.5 kg/m2 | 21.8 (20.6, 22.9) | 21.9 (20.6, 23.1) | 20.7 (19.4, 21.9) | 21.7 (20.4, 23.0) | 23.2 (21.9, 24.5) | 21.7 (20.3, 23.0) | 21.6 (20.3, 22.9) | 21.9 (20.7, 23.1) | 0.568 |  |
| 18.5-23.9 kg/m2 | 22.5 (22.0, 23.0) | 22.7 (22.2, 23.2) | 22.0 (21.5, 22.5) | 22.9 (22.4, 23.3) | 22.9 (22.5, 23.4) | 23.1 (22.6, 23.6) | 23.0 (22.5, 23.5) | 23.4 (22.9, 23.8) | 0.002 |  |
| 24.0-27.9 kg/m2 | 22.0 (21.1, 22.9) | 23.3 (22.4, 24.2) | 22.6 (21.8, 23.4) | 22.9 (22.1, 23.6) | 22.9 (22.2, 23.6) | 23.4 (22.6, 24.1) | 22.5 (21.8, 23.2) | 23.4 (22.8, 24.0) | 0.120 |  |
| ≥28.0 kg/m2 | 22.3 (20.4, 24.2) | 23.6 (21.7, 25.5) | 24.0 (22.3, 25.6) | 23.2 (21.8, 24.6) | 23.5 (22.2, 24.8) | 23.4 (22.1, 24.7) | 24.1 (22.9, 25.4) | 23.8 (22.8, 24.9) | 0.192 |  |
| **Lipid-soluble choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.050 |
| <18.5 kg/m2 | 118.1 (109.1, 127.0) | 121.3 (112.0, 130.7) | 122.7 (113.1, 132.2) | 130.4 (120.7, 140.1) | 127.4 (117.7, 137.0) | 131.8 (121.9, 141.8) | 140.8 (131.4, 150.2) | 151.4 (142.5, 160.2) | <0.001 |  |
| 18.5-23.9 kg/m2 | 113.5 (109.7, 117.3) | 122.0 (118.2, 125.7) | 133.8 (130.1, 137.5) | 134.8 (131.2, 138.4) | 133.5 (129.9, 137.1) | 140.0 (136.4, 143.6) | 148.3 (144.6, 151.9) | 151.0 (147.8, 154.3) | <0.001 |  |
| 24.0-27.9 kg/m2 | 122.3 (114.9, 129.6) | 130.4 (123.3, 137.5) | 150.5 (143.9, 157.2) | 143.3 (137.2, 149.3) | 141.0 (135.2, 146.9) | 146.4 (140.6, 152.2) | 150.1 (144.4, 155.8) | 161.5 (156.6, 166.5) | <0.001 |  |
| ≥28.0 kg/m2 | 139.9 (123.5, 156.3) | 137.2 (120.9, 153.6) | 148.9 (134.9, 163.0) | 148.8 (136.8, 160.7) | 142.7 (131.5, 153.8) | 150.3 (139.2, 161.4) | 158.2 (147.5, 168.9) | 165.1 (156.2, 174.0) | <0.001 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | 0.061 |
| <18.5 kg/m2 | 110.7 (102.3, 119.2) | 113.4 (104.5, 122.3) | 115.1 (106.1, 124.2) | 122.5 (113.3, 131.7) | 119.6 (110.4, 128.7) | 123.4 (113.9, 132.8) | 131.8 (122.9, 140.8) | 142.2 (133.8, 150.5) | <0.001 |  |
| 18.5-23.9 kg/m2 | 106.5 (102.9, 110.0) | 114.4 (110.8, 117.9) | 126.0 (122.5, 129.6) | 126.7 (123.3, 130.1) | 125.4 (121.9, 128.8) | 131.4 (128.0, 134.8) | 139.3 (135.8, 142.8) | 141.9 (138.8, 145.0) | <0.001 |  |
| 24.0-27.9 kg/m2 | 114.8 (107.8, 121.7) | 122.1 (115.4, 128.9) | 141.6 (135.3, 147.9) | 134.5 (128.8, 140.3) | 132.5 (126.9, 138.0) | 137.5 (132.0, 143.0) | 140.9 (135.5, 146.3) | 151.7 (147.0, 156.4) | <0.001 |  |
| ≥28.0 kg/m2 | 131.3 (115.8, 146.8) | 128.3 (112.8, 143.9) | 140.0 (126.7, 153.3) | 139.7 (128.4, 151.1) | 134.0 (123.5, 144.6) | 141.2 (130.7, 151.7) | 148.6 (138.5, 158.7) | 155.3 (146.8, 163.7) | <0.001 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | 0.007 |
| <18.5 kg/m2 | 7.3 (6.7, 7.9) | 7.9 (7.3, 8.5) | 7.5 (6.9, 8.2) | 7.9 (7.2, 8.5) | 7.8 (7.2, 8.4) | 8.4 (7.8, 9.1) | 9.0 (8.4, 9.6) | 9.2 (8.6, 9.8) | <0.001 |  |
| 18.5-23.9 kg/m2 | 7.0 (6.8, 7.3) | 7.6 (7.4, 7.9) | 7.8 (7.6, 8.1) | 8.1 (7.9, 8.4) | 8.1 (7.9, 8.4) | 8.6 (8.4, 8.8) | 9.0 (8.8, 9.2) | 9.2 (9.0, 9.4) | <0.001 |  |
| 24.0-27.9 kg/m2 | 7.5 (7.0, 7.9) | 8.2 (7.8, 8.7) | 8.9 (8.5, 9.4) | 8.7 (8.4, 9.1) | 8.6 (8.2, 8.9) | 8.9 (8.6, 9.3) | 9.2 (8.8, 9.5) | 9.8 (9.5, 10.1) | <0.001 |  |
| ≥28.0 kg/m2 | 8.6 (7.6, 9.7) | 8.9 (7.9, 10.0) | 9.0 (8.1, 9.8) | 9.0 (8.3, 9.8) | 8.6 (8.0, 9.3) | 9.1 (8.4, 9.8) | 9.6 (9.0, 10.3) | 9.8 (9.3, 10.4) | 0.002 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| <18.5 kg/m2 | 101.4 (92.1, 110.8) | 103.8 (94.1, 113.6) | 115.5 (105.7, 125.3) | 115.2 (105.3, 125.2) | 104.9 (95.0, 114.7) | 99.8 (89.6, 110.0) | 105.2 (95.5, 114.9) | 114.5 (105.3, 123.7) | 0.403 |  |
| 18.5-23.9 kg/m2 | 118.3 (114.3, 122.3) | 116.4 (112.5, 120.4) | 124.4 (120.5, 128.2) | 115.3 (111.6, 119.0) | 112.3 (108.6, 116.1) | 117.3 (113.6, 120.9) | 117.3 (113.5, 121.0) | 124.3 (120.8, 127.7) | 0.382 |  |
| 24.0-27.9 kg/m2 | 133.3 (125.3, 141.2) | 126.9 (119.2, 134.5) | 134.5 (127.4, 141.6) | 118.6 (112.1, 125.1) | 115.5 (109.3, 121.8) | 116.6 (110.4, 122.8) | 117.3 (111.2, 123.5) | 127.3 (121.9, 132.8) | 0.049 |  |
| ≥28.0 kg/m2 | 152.1 (133.8, 170.5) | 131.6 (113.3, 149.9) | 130.8 (115.2, 146.5) | 120.4 (106.9, 133.8) | 110.0 (97.5, 122.5) | 116.8 (104.4, 129.3) | 105.0 (93.0, 117.1) | 117.7 (107.5, 127.9) | <0.001 |  |

1 Adjusted for age, urbanization index, total energy intake, education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** **Table 5**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among men stratified by residence areas in the China Health and Nutrition Survey 1991-2011.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 211.8 (205.9, 217.7) | 224.1 (218.2, 229.9) | 240.1 (234.5, 245.8) | 241.2 (235.8, 246.6) | 231.8 (226.4, 237.3) | 242.8 (237.4, 248.3) | 257.1 (251.7, 262.5) | 260.6 (255.3, 265.8) | <0.001 |  |
| Urban area | 232.3 (224.5, 240.1) | 244.3 (236.4, 252.1) | 267.8 (260.8, 274.9) | 264.5 (258.0, 271.1) | 264.0 (257.2, 270.7) | 266.5 (259.7, 273.2) | 269.0 (262.2, 275.8) | 293.3 (287.7, 299.0) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 90.9 (88.6, 93.2) | 93.3 (91.0, 95.6) | 95.8 (93.6, 98.0) | 95.9 (93.8, 98.0) | 91.7 (89.6, 93.8) | 92.1 (90.0, 94.2) | 94.7 (92.6, 96.8) | 95.4 (93.4, 97.5) | 0.090 |  |
| Urban area | 84.9 (82.4, 87.3) | 84.4 (81.9, 86.9) | 89.2 (86.9, 91.4) | 88.4 (86.3, 90.5) | 87.3 (85.2, 89.5) | 88.2 (86.0, 90.4) | 89.9 (87.8, 92.1) | 95.5 (93.8, 97.3) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 58.0 (56.3, 59.7) | 59.5 (57.7, 61.2) | 62.3 (60.6, 63.9) | 62.1 (60.5, 63.7) | 58.1 (56.5, 59.6) | 57.6 (56.0, 59.2) | 60.2 (58.6, 61.8) | 60.8 (59.3, 62.4) | 0.686 |  |
| Urban area | 53.1 (51.4, 54.8) | 51.8 (50.1, 53.5) | 55.9 (54.4, 57.4) | 55.1 (53.7, 56.5) | 54.4 (53.0, 55.9) | 54.3 (52.8, 55.8) | 56.0 (54.5, 57.5) | 58.2 (57.0, 59.4) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 6.9 (6.6, 7.2) | 7.5 (7.2, 7.8) | 7.7 (7.4, 8.0) | 7.8 (7.5, 8.1) | 7.5 (7.2, 7.8) | 7.7 (7.4, 8.0) | 8.4 (8.1, 8.7) | 8.9 (8.6, 9.2) | <0.001 |  |
| Urban area | 6.4 (6.0, 6.8) | 6.7 (6.3, 7.1) | 7.0 (6.7, 7.4) | 7.2 (6.9, 7.5) | 7.4 (7.1, 7.8) | 7.9 (7.6, 8.3) | 8.2 (7.9, 8.6) | 9.4 (9.1, 9.7) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 26.0 (25.3, 26.7) | 26.3 (25.6, 27.0) | 25.8 (25.1, 26.4) | 26.1 (25.4, 26.7) | 26.1 (25.5, 26.7) | 26.8 (26.1, 27.4) | 26.1 (25.5, 26.8) | 25.7 (25.1, 26.3) | 0.978 |  |
| Urban area | 25.4 (24.4, 26.4) | 26.1 (25.1, 27.0) | 26.4 (25.5, 27.2) | 26.1 (25.3, 27.0) | 25.6 (24.7, 26.4) | 26.1 (25.2, 26.9) | 25.9 (25.0, 26.7) | 28.0 (27.3, 28.7) | 0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 121.8 (116.9, 126.7) | 131.5 (126.6, 136.3) | 145.3 (140.6, 150.0) | 146.1 (141.5, 150.6) | 140.7 (136.2, 145.2) | 151.4 (146.9, 156.0) | 163.1 (158.7, 167.6) | 165.9 (161.6, 170.3) | <0.001 |  |
| Urban area | 148.5 (141.6, 155.4) | 160.8 (153.9, 167.7) | 179.6 (173.4, 185.8) | 176.9 (171.1, 182.6) | 177.2 (171.3, 183.1) | 179.0 (173.1, 184.9) | 179.6 (173.6, 185.6) | 199.1 (194.1, 204.0) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 114.2 (109.6, 118.8) | 123.3 (118.7, 127.9) | 136.8 (132.4, 141.3) | 137.3 (133.0, 141.6) | 132.0 (127.7, 136.3) | 141.9 (137.6, 146.2) | 152.9 (148.7, 157.1) | 155.8 (151.6, 159.9) | <0.001 |  |
| Urban area | 139.0 (132.6, 145.5) | 150.0 (143.5, 156.6) | 168.2 (162.3, 174.0) | 165.5 (160.1, 170.9) | 166.1 (160.6, 171.7) | 167.8 (162.2, 173.4) | 168.2 (162.6, 173.8) | 186.0 (181.3, 190.7) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 7.6 (7.2, 7.9) | 8.2 (7.9, 8.5) | 8.4 (8.1, 8.8) | 8.8 (8.5, 9.1) | 8.7 (8.4, 9.0) | 9.5 (9.2, 9.8) | 10.2 (9.9, 10.5) | 10.2 (9.9, 10.5) | <0.001 |  |
| Urban area | 9.5 (9.0, 9.9) | 10.7 (10.3, 11.2) | 11.5 (11.1, 11.9) | 11.4 (11.0, 11.8) | 11.1 (10.7, 11.5) | 11.2 (10.8, 11.6) | 11.4 (11.0, 11.8) | 13.0 (12.7, 13.4) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 142.3 (136.5, 148.1) | 144.0 (138.3, 149.7) | 154.1 (148.6, 159.5) | 140.1 (134.9, 145.3) | 138.8 (133.7, 144.0) | 145.1 (139.9, 150.3) | 139.5 (134.4, 144.7) | 149.4 (144.4, 154.5) | 0.961 |  |
| Urban area | 146.7 (140.4, 152.9) | 135.5 (129.3, 141.8) | 142.7 (137.1, 148.2) | 139.1 (134.0, 144.2) | 127.6 (122.4, 132.9) | 127.1 (121.8, 132.4) | 136.7 (131.4, 142.1) | 143.8 (139.3, 148.3) | 0.718 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models

**Supplemental Table 6**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among women stratified by residence areas in the China Health and Nutrition Survey 1991-2011.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 184.9 (179.2,190.6) | 196.9 (191.3,202.5) | 207.9 (202.4,213.4) | 210.8 (205.5,216.1) | 204.9 (199.7,210.1) | 214.6 (209.5,219.8) | 226.9 (221.8,232.0) | 229.6 (224.6,234.6) | <0.001 |  |
| Urban area | 212.7 (206.1,219.3) | 218.9 (212.2,225.6) | 242.1 (236.0,248.1) | 238.3 (232.8,243.8) | 240.1 (234.6,245.7) | 238.6 (233.0,244.2) | 245.0 (239.4,250.6) | 262.8 (258.2,267.3) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 79.5 (77.3,81.6) | 81.9 (79.8,84.0) | 82.4 (80.3,84.5) | 82.4 (80.4,84.4) | 79.6 (77.7,81.6) | 78.8 (76.8,80.7) | 82.0 (80.1,84.0) | 83.0 (81.1,84.9) | 0.302 |  |
| Urban area | 75.7 (73.6,77.8) | 75.6 (73.5,77.7) | 79.0 (77.1,81.0) | 79.0 (77.3,80.8) | 78.9 (77.1,80.7) | 79.8 (78.0,81.5) | 82.3 (80.5,84.1) | 86.4 (84.9,87.8) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 50.7 (49.1,52.4) | 52.4 (50.8,54.0) | 53.7 (52.1,55.3) | 53.3 (51.8,54.8) | 50.2 (48.7,51.6) | 49.1 (47.6,50.5) | 52.2 (50.7,53.7) | 53.0 (51.6,54.4) | 0.748 |  |
| Urban area | 46.9 (45.4,48.3) | 46.0 (44.5,47.4) | 49.7 (48.4,51.0) | 49.0 (47.8,50.2) | 49.1 (47.9,50.4) | 49.0 (47.8,50.3) | 51.3 (50.1,52.5) | 52.9 (51.9,53.9) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 6.5 (6.2,6.8) | 6.9 (6.6,7.2) | 6.9 (6.6,7.2) | 6.9 (6.6,7.2) | 6.9 (6.7,7.2) | 7.2 (6.9,7.4) | 7.7 (7.4,8.0) | 8.1 (7.8,8.4) | <0.001 |  |
| Urban area | 6.3 (5.9,6.6) | 6.5 (6.1,6.8) | 6.9 (6.6,7.3) | 6.9 (6.6,7.2) | 7.0 (6.7,7.4) | 7.7 (7.4,8.0) | 7.8 (7.5,8.2) | 8.8 (8.5,9.0) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 22.3 (21.7,22.9) | 22.6 (21.9,23.2) | 21.8 (21.2,22.4) | 22.2 (21.6,22.8) | 22.5 (22.0,23.1) | 22.6 (22.0,23.1) | 22.1 (21.6,22.7) | 21.9 (21.3,22.4) | 0.382 |  |
| Urban area | 22.6 (21.8,23.3) | 23.2 (22.5,23.9) | 22.5 (21.8,23.2) | 23.3 (22.7,23.9) | 22.8 (22.2,23.4) | 23.1 (22.5,23.8) | 23.3 (22.7,23.9) | 24.7 (24.2,25.2) | <0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 106.2 (101.4,111.1) | 115.8 (111.0,120.5) | 126.3 (121.6,131.0) | 129.2 (124.6,133.7) | 125.9 (121.5,130.3) | 136.6 (132.2,141.0) | 145.6 (141.3,150.0) | 147.4 (143.2,151.7) | <0.001 |  |
| Urban area | 137.9 (132.1,143.7) | 144.1 (138.2,150.0) | 163.8 (158.5,169.1) | 159.8 (154.9,164.6) | 161.7 (156.8,166.5) | 159.2 (154.3,164.2) | 162.8 (157.9,167.7) | 177.4 (173.3,181.4) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 99.8 (95.1,104.4) | 108.6 (104.1,113.2) | 119.1 (114.7,123.6) | 121.5 (117.2,125.8) | 118.2 (114.0,122.4) | 128.2 (124.1,132.4) | 136.8 (132.7,141.0) | 138.7 (134.7,142.7) | <0.001 |  |
| Urban area | 129.1 (123.6,134.6) | 134.6 (129.0,140.2) | 153.5 (148.5,158.6) | 149.6 (145.0,154.2) | 151.8 (147.2,156.4) | 149.4 (144.7,154.0) | 152.6 (148.0,157.3) | 166.1 (162.3,169.9) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 6.4 (6.1,6.7) | 7.1 (6.8,7.4) | 7.2 (6.9,7.5) | 7.6 (7.3,7.9) | 7.7 (7.4,8.0) | 8.4 (8.1,8.6) | 8.8 (8.6,9.1) | 8.8 (8.5,9.0) | <0.001 |  |
| Urban area | 8.8 (8.4,9.2) | 9.5 (9.1,9.9) | 10.3 (9.9,10.6) | 10.2 (9.8,10.5) | 9.9 (9.5,10.2) | 9.9 (9.6,10.2) | 10.2 (9.8,10.5) | 11.2 (11,11.5) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Rural area | 118.4 (112.7,124.1) | 119.5 (113.9,125.1) | 129.7 (124.3,135.1) | 118.7 (113.5,123.9) | 116.0 (110.9,121.1) | 122.4 (117.3,127.5) | 117.9 (112.9,123.0) | 127.1 (122.2,132.0) | 0.300 |  |
| Urban area | 119.2 (113.7,124.8) | 111.1 (105.5,116.7) | 114.6 (109.6,119.5) | 111.8 (107.3,116.2) | 106.7 (102.2,111.3) | 105.9 (101.4,110.4) | 115.9 (111.3,120.5) | 119.7 (115.8,123.5) | 0.273 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 7**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among men stratified by geographic regions in the China Health and Nutrition Survey 1991-2011.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 227.1 (219.5, 234.6) | 254.4 (246.6, 262.3) | 259.6 (252.4, 266.9) | 254.1 (247.6, 260.5) | 239.4 (233.0, 245.9) | 253.0 (246.5, 259.5) | 259.5 (253.2, 265.9) | 274.4 (268.5, 280.4) | <0.001 |  |
| Southern | 211.4 (206.3, 216.4) | 216.3 (211.3, 221.3) | 240.4 (235.5, 245.3) | 242.8 (237.9, 247.7) | 240.5 (235.6, 245.4) | 244.9 (240.0, 249.8) | 258.6 (253.7, 263.5) | 264.9 (260.5, 269.3) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 91.1 (88.7, 93.4) | 95.5 (93.0, 98.0) | 94.7 (92.4, 97.0) | 91.9 (89.9, 93.9) | 85.2 (83.2, 87.3) | 90.8 (88.7, 92.8) | 89.8 (87.8, 91.8) | 95.3 (93.4, 97.2) | 0.343 |  |
| Southern | 87.3 (85.3, 89.4) | 88.1 (86.1, 90.2) | 93.7 (91.7, 95.7) | 95.9 (93.9, 97.9) | 95.7 (93.7, 97.7) | 92.6 (90.5, 94.6) | 97.7 (95.7, 99.7) | 98.0 (96.3, 99.8) | <0.001 |  |
| Free choline (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 61.9 (60.2, 63.6) | 65.4 (63.6, 67.1) | 63.9 (62.3, 65.5) | 60.7 (59.2, 62.1) | 56.0 (54.6, 57.5) | 59.3 (57.8, 60.7) | 59.1 (57.6, 60.5) | 62.7 (61.3, 64.0) | <0.001 |  |
| Southern | 52.2 (50.7, 53.8) | 51.9 (50.4, 53.4) | 57.6 (56.1, 59.0) | 59.6 (58.1, 61.1) | 58.1 (56.7, 59.6) | 55.1 (53.6, 56.6) | 59.5 (58.1, 61.0) | 58.8 (57.5, 60.1) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 6.9 (6.5, 7.4) | 7.3 (6.8, 7.7) | 8.0 (7.6, 8.4) | 8.1 (7.7, 8.5) | 7.0 (6.7, 7.4) | 7.9 (7.5, 8.3) | 8.2 (7.8, 8.5) | 9.1 (8.7, 9.4) | <0.001 |  |
| Southern | 6.4 (6.2, 6.7) | 7.1 (6.8, 7.4) | 7.2 (6.9, 7.4) | 7.3 (7.1, 7.6) | 8.0 (7.8, 8.3) | 7.9 (7.6, 8.1) | 8.7 (8.4, 8.9) | 9.4 (9.2, 9.6) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.002 |
| Northern | 22.3 (21.5, 23.0) | 22.9 (22.2, 23.7) | 23.0 (22.3, 23.7) | 23.1 (22.5, 23.7) | 22.1 (21.5, 22.7) | 23.6 (22.9, 24.2) | 22.6 (22.0, 23.2) | 23.5 (22.9, 24.1) | 0.115 |  |
| Southern | 28.7 (27.9, 29.4) | 29.0 (28.3, 29.7) | 28.8 (28.1, 29.5) | 28.9 (28.2, 29.6) | 29.5 (28.8, 30.2) | 29.5 (28.8, 30.2) | 29.4 (28.7, 30.1) | 29.8 (29.2, 30.4) | 0.003 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 137.7 (130.9, 144.4) | 160.4 (153.4, 167.4) | 166.3 (159.9, 172.8) | 163.5 (157.7, 169.3) | 155.5 (149.7, 161.3) | 163.6 (157.8, 169.4) | 171.1 (165.4, 176.7) | 180.8 (175.5, 186.1) | <0.001 |  |
| Southern | 124.2 (120.1, 128.2) | 128.2 (124.1, 132.2) | 146.9 (143.0, 150.9) | 147.0 (143.0, 150.9) | 144.8 (140.9, 148.8) | 152.5 (148.5, 156.5) | 160.9 (157.0, 164.9) | 167.1 (163.6, 170.6) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 130.5 (124.1, 136.9) | 151.8 (145.2, 158.5) | 157.7 (151.6, 163.8) | 154.6 (149.2, 160.1) | 146.9 (141.4, 152.4) | 154.6 (149.1, 160.2) | 161.6 (156.3, 167.0) | 170.8 (165.8, 175.9) | <0.001 |  |
| Southern | 115.0 (111.1, 118.8) | 118.5 (114.6, 122.3) | 136.8 (133.1, 140.5) | 136.8 (133.1, 140.5) | 134.8 (131.0, 138.5) | 141.7 (138.0, 145.5) | 149.6 (145.8, 153.3) | 155.3 (151.9, 158.6) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | 0.015 |
| Northern | 7.1 (6.7, 7.5) | 8.6 (8.1, 9.0) | 8.6 (8.3, 9.0) | 8.8 (8.5, 9.2) | 8.5 (8.2, 8.9) | 9.0 (8.6, 9.3) | 9.4 (9.1, 9.8) | 10.0 (9.7, 10.3) | <0.001 |  |
| Southern | 9.2 (8.9, 9.5) | 9.7 (9.4, 10.0) | 10.1 (9.8, 10.4) | 10.2 (9.9, 10.5) | 10.1 (9.8, 10.4) | 10.8 (10.5, 11.1) | 11.5 (11.2, 11.8) | 11.9 (11.6, 12.1) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 220.8 (214.1, 227.5) | 208.7 (201.9, 215.5) | 208.0 (201.7, 214.2) | 186.6 (180.9, 192.2) | 180.8 (175.2, 186.5) | 186.2 (180.5, 191.8) | 179.7 (174.1, 185.2) | 184.6 (179.2, 190.0) | <0.001 |  |
| Southern | 88.0 (83.7, 92.4) | 90.3 (86.0, 94.5) | 99.0 (94.9, 103.1) | 97.1 (93.0, 101.3) | 91.7 (87.6, 95.8) | 92.1 (87.9, 96.3) | 94.3 (90.2, 98.5) | 104.1 (100.3, 107.8) | <0.001 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), and household income level (quartiles).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 8**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among women stratified by geographic regions in the China Health and Nutrition Survey 1991-2011.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 198.0 (191.3, 204.7) | 220.1 (213.4, 226.8) | 226.4 (219.9, 232.8) | 220.5 (214.7, 226.2) | 212.3 (206.7, 217.9) | 222.9 (217.3, 228.5) | 227.6 (222.1, 233.1) | 238.6 (233.6, 243.6) | <0.001 |  |
| Southern | 190.0 (185.3, 194.7) | 193.9 (189.2, 198.5) | 213.5 (208.9, 218.0) | 218.1 (213.6, 222.5) | 217.3 (212.8, 221.7) | 219.7 (215.3, 224.2) | 234.4 (229.9, 238.8) | 239.8 (235.9, 243.6) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 77.4 (75.3, 79.4) | 81.6 (79.5, 83.7) | 80.0 (78.0, 82.0) | 77.6 (75.8, 79.3) | 72.5 (70.8, 74.3) | 76.4 (74.7, 78.2) | 75.9 (74.2, 77.6) | 80.8 (79.3, 82.4) | 0.171 |  |
| Southern | 79.1 (77.3, 81.0) | 80.0 (78.1, 81.8) | 83.4 (81.6, 85.2) | 85.5 (83.7, 87.3) | 86.4 (84.7, 88.2) | 82.8 (81.0, 84.5) | 89.0 (87.2, 90.7) | 89.3 (87.7, 90.8) | <0.001 |  |
| Free choline (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 52.3 (50.8, 53.8) | 55.4 (54.0, 56.9) | 53.5 (52.0, 54.9) | 50.6 (49.3, 51.8) | 47.2 (45.9, 48.4) | 49.2 (48.0, 50.5) | 49.4 (48.2, 50.6) | 52.7 (51.6, 53.8) | <0.001 |  |
| Southern | 47.5 (46.1, 48.9) | 47.5 (46.1, 48.9) | 51.8 (50.5, 53.2) | 53.3 (51.9, 54.6) | 52.5 (51.2, 53.8) | 49.4 (48.1, 50.7) | 54.7 (53.3, 56.0) | 54.2 (53.0, 55.3) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 6.2 (5.8, 6.6) | 6.6 (6.2, 7.0) | 7.2 (6.8, 7.5) | 7.2 (6.9, 7.5) | 6.4 (6.1, 6.7) | 7.3 (7.0, 7.6) | 7.3 (7.0, 7.6) | 8.0 (7.7, 8.3) | <0.001 |  |
| Southern | 6.2 (6.0, 6.4) | 6.7 (6.4, 6.9) | 6.7 (6.4, 6.9) | 6.7 (6.5, 6.9) | 7.5 (7.3, 7.7) | 7.4 (7.2, 7.7) | 8.3 (8.0, 8.5) | 8.8 (8.6, 9.0) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 18.9 (18.3, 19.5) | 19.6 (19.0, 20.2) | 19.5 (18.9, 20.1) | 19.8 (19.2, 20.3) | 18.9 (18.4, 19.4) | 19.9 (19.3, 20.4) | 19.2 (18.7, 19.7) | 20.1 (19.6, 20.5) | 0.100 |  |
| Southern | 25.5 (24.9, 26.1) | 25.8 (25.3, 26.4) | 24.9 (24.3, 25.5) | 25.5 (25.0, 26.1) | 26.4 (25.9, 27.0) | 25.9 (25.4, 26.5) | 26.1 (25.5, 26.6) | 26.3 (25.8, 26.8) | 0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | 0.711 |
| Northern | 122.2 (116.1, 128.2) | 140.0 (133.9, 146.1) | 147.8 (141.9, 153.6) | 144.3 (139.1, 149.5) | 141.1 (136.0, 146.1) | 147.7 (142.7, 152.8) | 153.1 (148.1, 158.1) | 159.3 (154.7, 163.9) | <0.001 |  |
| Southern | 110.9 (107.0, 114.7) | 113.9 (110.0, 117.7) | 130.3 (126.6, 134.0) | 132.7 (129.0, 136.4) | 130.9 (127.2, 134.6) | 137.2 (133.5, 140.8) | 145.5 (141.8, 149.1) | 150.8 (147.6, 153.9) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | 0.009 |
| Northern | 115.9 (110.2, 121.6) | 132.5 (126.7, 138.3) | 140.2 (134.6, 145.8) | 136.6 (131.6, 141.5) | 133.5 (128.7, 138.3) | 139.7 (134.9, 144.5) | 144.8 (140.0, 149.5) | 150.6 (146.3, 155.0) | <0.001 |  |
| Southern | 99.5 (96.4, 102.5) | 101.6 (98.5, 104.6) | 115.5 (112.5, 118.4) | 116.9 (114.0, 119.8) | 114.4 (111.5, 117.3) | 121.5 (118.6, 124.4) | 127.5 (124.6, 130.4) | 136.1 (133.5, 138.7) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | 0.023 |
| Northern | 6.3 (5.9, 6.6) | 7.4 (7.1, 7.8) | 7.5 (7.2, 7.9) | 7.8 (7.5, 8.1) | 7.6 (7.3, 7.8) | 8.0 (7.7, 8.3) | 8.3 (8.0, 8.6) | 8.7 (8.4, 8.9) | <0.001 |  |
| Southern | 8.1 (7.9, 8.4) | 8.5 (8.2, 8.8) | 8.9 (8.6, 9.2) | 9.1 (8.8, 9.4) | 9.0 (8.8, 9.3) | 9.6 (9.3, 9.8) | 10.0 (9.8, 10.3) | 10.3 (10.0, 10.5) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Northern | 179.5 (173.5, 185.5) | 171.7 (165.7, 177.7) | 170.4 (164.7, 176.1) | 153.7 (148.6, 158.8) | 148.2 (143.2, 153.1) | 152.9 (148.0, 157.8) | 148.4 (143.4, 153.3) | 152.3 (147.7, 157.0) | <0.001 |  |
| Southern | 74.7 (70.6, 78.9) | 74.7 (70.6, 78.8) | 83.9 (79.9, 87.9) | 82.3 (78.4, 86.3) | 79.4 (75.5, 83.3) | 80.1 (76.3, 84.0) | 82.8 (79.0, 86.7) | 91.4 (88.0, 94.9) | <0.001 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), and household income level (quartiles).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** Table 9. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among men stratified by quartiles of urbanization indexes in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 191.3 (174.3, 208.3) | 196.4 (179.5, 213.2) | 204.3 (187.8, 220.8) | 210.9 (194.9, 226.9) | 195.9 (180.0, 211.8) | 209.5 (193.5, 225.4) | 224.5 (208.5, 240.5) | 236.3 (220.3, 252.4) | <0.001 |  |
| Q2 | 213.3 (202.1, 224.4) | 226.1 (215.2, 236.9) | 239.7 (229.8, 249.5) | 251.7 (242.5, 260.9) | 243.8 (234.8, 252.9) | 258.3 (249.1, 267.4) | 265.6 (256.2, 275.0) | 260.5 (249.8, 271.2) | <0.001 |  |
| Q3 | 240.8 (230.7, 251.0) | 246.2 (236.2, 256.1) | 272.7 (264.2, 281.1) | 264.6 (257.2, 272.0) | 254.3 (246.6, 261.9) | 247.4 (239.5, 255.3) | 257.4 (249.6, 265.1) | 268.0 (259.3, 276.6) | 0.096 |  |
| Q4 | 238.7 (226.2, 251.2) | 263.6 (251.9, 275.3) | 285.6 (276.7, 294.5) | 267.1 (259.5, 274.7) | 277.4 (269.2, 285.5) | 284.6 (276.0, 293.3) | 290.5 (281.6, 299.4) | 310.0 (301.2, 318.8) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 93.0 (85.6, 100.5) | 94.0 (86.6, 101.4) | 94.1 (86.9, 101.4) | 99.4 (92.4, 106.4) | 86.9 (80.0, 93.9) | 89.8 (82.8, 96.8) | 91.9 (84.9, 98.9) | 95.8 (88.8, 102.8) | 0.294 |  |
| Q2 | 89.1 (85.2, 93.0) | 92.4 (88.6, 96.2) | 93.4 (90.0, 96.9) | 95.1 (91.9, 98.3) | 93.6 (90.4, 96.7) | 89.8 (86.6, 93.0) | 93.5 (90.2, 96.8) | 90.0 (86.3, 93.8) | 0.430 |  |
| Q3 | 87.3 (84.0, 90.6) | 88.0 (84.8, 91.3) | 92.6 (89.8, 95.3) | 90.1 (87.7, 92.5) | 89.6 (87.1, 92.1) | 87.7 (85.2, 90.3) | 90.9 (88.3, 93.4) | 96.4 (93.5, 99.2) | 0.038 |  |
| Q4 | 85.1 (80.8, 89.4) | 86.3 (82.3, 90.3) | 94.0 (91.0, 97.1) | 89.3 (86.7, 91.9) | 92.0 (89.2, 94.8) | 95.9 (93.0, 98.9) | 97.1 (94.1100.2) | 101.7 (98.6104.7) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 60.1 (54.3, 65.9) | 61.6 (55.8, 67.3) | 63.3 (57.7, 68.9) | 66.7 (61.2, 72.2) | 56.2 (50.8, 61.7) | 56.4 (50.9, 61.8) | 59.9 (54.4, 65.3) | 63.6 (58.2, 69.1) | 0.234 |  |
| Q2 | 57.3 (54.5, 60.1) | 59.5 (56.7, 62.2) | 60.2 (57.7, 62.7) | 60.8 (58.5, 63.2) | 59.0 (56.7, 61.3) | 56.5 (54.1, 58.8) | 59.7 (57.3, 62.1) | 56.6 (53.9, 59.3) | 0.986 |  |
| Q3 | 55.6 (53.3, 57.9) | 54.9 (52.6, 57.1) | 59.0 (57.1, 60.9) | 56.9 (55.2, 58.6) | 56.6 (54.8, 58.3) | 54.3 (52.5, 56.1) | 56.6 (54.8, 58.3) | 59.1 (57.1, 61.1) | 0.417 |  |
| Q4 | 53.3 (50.4, 56.1) | 52.8 (50.1, 55.4) | 58.4 (56.4, 60.5) | 55.1 (53.3, 56.8) | 55.9 (54.0, 57.7) | 58.6 (56.6, 60.6) | 59.5 (57.5, 61.6) | 61.7 (59.6, 63.7) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 6.5 (5.5, 7.5) | 7.4 (6.4, 8.4) | 7.1 (6.1, 8.1) | 7.7 (6.7, 8.6) | 6.8 (5.9, 7.8) | 7.3 (6.4, 8.3) | 8.5 (7.5, 9.5) | 9.1 (8.1, 10.1) | <0.001 |  |
| Q2 | 6.8 (6.2, 7.4) | 7.0 (6.4, 7.6) | 7.3 (6.8, 7.8) | 7.8 (7.3, 8.2) | 7.8 (7.3, 8.2) | 7.4 (6.9, 7.9) | 7.7 (7.2, 8.2) | 8.1 (7.5, 8.7) | 0.007 |  |
| Q3 | 7.0 (6.5, 7.4) | 7.5 (7.1, 8.0) | 7.8 (7.5, 8.2) | 7.3 (6.9, 7.6) | 7.2 (6.9, 7.5) | 7.4 (7.1, 7.8) | 8.1 (7.8, 8.5) | 9.0 (8.6, 9.4) | <0.001 |  |
| Q4 | 6.0 (5.3, 6.8) | 6.5 (5.8, 7.2) | 7.5 (7.0, 8.1) | 7.7 (7.2, 8.1) | 8.4 (7.9, 8.9) | 9.0 (8.5, 9.5) | 9.3 (8.8, 9.9) | 10.4 (9.9, 10.9) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 26.9 (24.9, 28.8) | 25.3 (23.3, 27.2) | 23.8 (21.9, 25.7) | 24.9 (23.1, 26.8) | 23.7 (21.8, 25.5) | 26.0 (24.2, 27.8) | 23.3 (21.5, 25.2) | 22.9 (21.0, 24.7) | <0.001 |  |
| Q2 | 25.0 (23.7, 26.4) | 26.0 (24.7, 27.3) | 25.9 (24.7, 27.1) | 26.5 (25.4, 27.6) | 26.8 (25.7, 27.9) | 26.0 (24.8, 27.1) | 26.0 (24.9, 27.2) | 25.2 (23.9, 26.5) | 0.292 |  |
| Q3 | 24.8 (23.6, 26.0) | 25.7 (24.5, 26.9) | 25.8 (24.8, 26.8) | 26.0 (25.1, 26.9) | 26.0 (25.1, 26.9) | 26.2 (25.2, 27.1) | 26.4 (25.4, 27.3) | 28.3 (27.3, 29.4) | 0.012 |  |
| Q4 | 25.8 (24.1, 27.4) | 27.0 (25.5, 28.5) | 28.1 (26.9, 29.2) | 26.6 (25.6, 27.6) | 27.8 (26.7, 28.8) | 28.3 (27.2, 29.4) | 28.3 (27.1, 29.4) | 29.6 (28.5, 30.8) | 0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 100.8 (87.4114.2) | 104.8 (91.4118.1) | 112.5 (99.5125.6) | 112.8 (100.1125.5) | 109.2 (96.6121.8) | 120.0 (107.4132.6) | 132.9 (120.3145.6) | 140.9 (128.2153.5) | <0.001 |  |
| Q2 | 124.8 (115.1, 134.4) | 134.1 (124.7, 143.5) | 147.2 (138.7, 155.7) | 157.2 (149.3, 165.2) | 150.8 (143.0, 158.7) | 169.4 (161.4, 177.3) | 173.1 (165.0, 181.2) | 171.6 (162.3, 180.9) | <0.001 |  |
| Q3 | 154.7 (145.8, 163.6) | 159.1 (150.4, 167.8) | 181.1 (173.7, 188.5) | 175.4 (168.9, 181.8) | 165.1 (158.4, 171.8) | 160.4 (153.5, 167.3) | 166.8 (160.0, 173.6) | 172.4 (164.8, 179.9) | 0.316 |  |
| Q4 | 154.5 (143.7, 165.3) | 178.1 (168.0, 188.1) | 192.3 (184.6, 200.0) | 178.5 (171.9, 185.0) | 186.1 (179.1, 193.1) | 189.8 (182.4, 197.2) | 194.1 (186.4, 201.8) | 209.6 (202.0, 217.2) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 94.7 (81.9, 107.4) | 98.9 (86.2, 111.5) | 106.5 (94.1, 118.9) | 106.4 (94.4, 118.4) | 102.6 (90.6, 114.5) | 112.7 (100.7, 124.7) | 124.6 (112.5, 136.6) | 132.3 (120.3, 144.4) | <0.001 |  |
| Q2 | 116.8 (107.7, 126.0) | 125.7 (116.8, 134.6) | 138.4 (130.3, 146.5) | 148.0 (140.4, 155.5) | 141.7 (134.3, 149.1) | 159.1 (151.6, 166.6) | 162.7 (155.0, 170.4) | 161.6 (152.8, 170.3) | <0.001 |  |
| Q3 | 145.2 (136.8, 153.6) | 148.6 (140.4, 156.9) | 170.1 (163.1, 177.1) | 164.1 (158.0, 170.2) | 154.7 (148.3, 161.0) | 149.9 (143.4, 156.4) | 155.7 (149.3, 162.1) | 160.7 (153.6, 167.8) | 0.401 |  |
| Q4 | 144.8 (134.6, 155.0) | 166.3 (156.8, 175.9) | 180.1 (172.8, 187.4) | 167.0 (160.8, 173.2) | 174.0 (167.3, 180.6) | 177.4 (170.4, 184.4) | 181.7 (174.4, 188.9) | 195.8 (188.6, 202.9) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 6.0 (5.2, 6.9) | 5.8 (5.0, 6.7) | 5.9 (5.1, 6.8) | 6.4 (5.6, 7.2) | 6.7 (5.8, 7.5) | 7.3 (6.5, 8.2) | 8.4 (7.6, 9.2) | 8.6 (7.8, 9.4) | <0.001 |  |
| Q2 | 7.9 (7.3, 8.6) | 8.4 (7.7, 9.0) | 8.8 (8.2, 9.3) | 9.2 (8.7, 9.7) | 9.1 (8.6, 9.6) | 10.2 (9.7, 10.7) | 10.4 (9.9, 10.9) | 10.1 (9.5, 10.7) | <0.001 |  |
| Q3 | 9.5 (8.9, 10.1) | 10.5 (9.9, 11.1) | 11.0 (10.5, 11.5) | 11.2 (10.8, 11.7) | 10.4 (10.0, 10.9) | 10.5 (10.0, 10.9) | 11.1 (10.7, 11.6) | 11.6 (11.1, 12.1) | 0.003 |  |
| Q4 | 9.7 (9.0, 10.5) | 11.7 (11.1, 12.4) | 12.2 (11.7, 12.8) | 11.5 (11.1, 12.0) | 12.1 (11.6, 12.6) | 12.4 (11.9, 12.9) | 12.4 (11.9, 13.0) | 13.9 (13.4, 14.4) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 130.4 (113.0, 147.8) | 153.1 (135.9, 170.3) | 150.7 (133.9, 167.5) | 144.7 (128.3, 161.1) | 142.2 (126.0, 158.5) | 155.1 (138.9, 171.3) | 149.4 (133.1, 165.6) | 162.8 (146.5, 179.2) | <0.001 |  |
| Q2 | 134.5 (124.2, 144.8) | 129.1 (119.2, 139.1) | 146.1 (137.1, 155.2) | 136.2 (127.8, 144.6) | 121.5 (113.2, 129.7) | 128.9 (120.5, 137.2) | 129.4 (120.8, 138.0) | 139.6 (129.9, 149.4) | 0.107 |  |
| Q3 | 168.3 (159.3, 177.4) | 152.8 (144.0, 161.6) | 157.5 (150.1, 164.9) | 139.1 (132.5, 145.6) | 139.0 (132.2, 145.7) | 140.2 (133.3, 147.2) | 138.4 (131.5, 145.3) | 143.4 (135.8, 151.1) | <0.001 |  |
| Q4 | 145.5 (136.0, 155.0) | 129.3 (120.5, 138.2) | 147.1 (140.4, 153.9) | 135.7 (129.9, 141.5) | 127.9 (121.8, 134.1) | 124.1 (117.6, 130.6) | 128.6 (121.8, 135.3) | 149.9 (143.2, 156.6) | 0.066 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 10**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among women stratified by quartiles of urbanization indexes in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 176.5 (160.3, 192.7) | 182.2 (166.0, 198.3) | 184.6 (168.7, 200.4) | 193.2 (177.7, 208.8) | 183.1 (167.7, 198.4) | 199.1 (183.7, 214.4) | 207.7 (192.2, 223.1) | 217.6 (202.2, 232.9) | <0.001 |  |
| Q2 | 180.4 (170.1, 190.7) | 194.6 (184.5, 204.7) | 207.5 (198.1, 216.8) | 216.0 (207.2, 224.9) | 210.0 (201.2, 218.7) | 219.7 (210.9, 228.6) | 232.1 (223.1, 241.1) | 222.2 (212.4, 232.0) | <0.001 |  |
| Q3 | 216.7 (207.6, 225.7) | 218.8 (209.8, 227.9) | 244.3 (236.7, 251.9) | 241.8 (235.2, 248.5) | 235.7 (229.0, 242.5) | 226.0 (219.2, 232.8) | 232.4 (225.6, 239.2) | 247.4 (239.9, 254.8) | 0.035 |  |
| Q4 | 210.6 (199.8, 221.4) | 228.8 (218.6, 238.9) | 249.5 (241.7, 257.3) | 234.3 (227.7, 240.8) | 251.7 (244.9, 258.6) | 257.2 (250.0, 264.5) | 267.0 (259.4, 274.6) | 282.8 (275.5, 290.2) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 84.3 (77.1, 91.4) | 84.7 (77.6, 91.8) | 83.6 (76.6, 90.6) | 86.4 (79.5, 93.3) | 77.6 (70.8, 84.4) | 78.9 (72.1, 85.7) | 82.2 (75.4, 89.0) | 84.1 (77.3, 90.9) | 0.066 |  |
| Q2 | 77.3 (74.1, 80.5) | 81.7 (78.5, 84.8) | 79.8 (76.8, 82.7) | 81.1 (78.3, 83.9) | 80.4 (77.6, 83.1) | 75.7 (73.0, 78.5) | 78.7 (75.9, 81.6) | 77.3 (74.2, 80.4) | 0.394 |  |
| Q3 | 76.7 (73.7, 79.6) | 79.1 (76.2, 82.1) | 81.3 (78.9, 83.8) | 80.4 (78.3, 82.6) | 78.6 (76.4, 80.8) | 76.9 (74.7, 79.1) | 79.8 (77.6, 82.0) | 85.9 (83.5, 88.4) | 0.048 |  |
| Q4 | 74.3 (70.6, 78.0) | 74.8 (71.3, 78.2) | 81.7 (79.1, 84.4) | 78.8 (76.5, 81.0) | 83.4 (81.1, 85.7) | 86.4 (83.9, 88.9) | 89.5 (86.9, 92.1) | 92.4 (89.9, 94.9) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 54.2 (48.6, 59.8) | 55.1 (49.5, 60.7) | 56.0 (50.5, 61.5) | 57.8 (52.4, 63.2) | 49.7 (44.4, 55.0) | 49.6 (44.3, 55.0) | 53.3 (48.0, 58.7) | 55.8 (50.5, 61.2) | 0.088 |  |
| Q2 | 49.3 (46.9, 51.8) | 52.5 (50.2, 54.9) | 51.8 (49.6, 54.0) | 52.0 (49.9, 54.1) | 50.5 (48.5, 52.6) | 46.9 (44.8, 49.0) | 50.0 (47.9, 52.2) | 48.8 (46.5, 51.1) | 0.082 |  |
| Q3 | 48.4 (46.4, 50.5) | 49.5 (47.4, 51.6) | 51.5 (49.7, 53.2) | 50.3 (48.7, 51.8) | 49.0 (47.5, 50.6) | 47.3 (45.7, 48.8) | 49.3 (47.7, 50.9) | 52.8 (51.1, 54.5) | 0.476 |  |
| Q4 | 46.9 (44.4, 49.4) | 45.8 (43.4, 48.1) | 51.2 (49.4, 53.0) | 48.2 (46.7, 49.7) | 50.4 (48.8, 52.0) | 52.0 (50.4, 53.7) | 54.8 (53.1, 56.6) | 55.5 (53.8, 57.2) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 6.8 (5.8, 7.7) | 7.3 (6.4, 8.3) | 6.9 (6.0, 7.9) | 7.0 (6.1, 7.9) | 6.8 (5.9, 7.7) | 7.1 (6.2, 8.0) | 8.3 (7.4, 9.2) | 8.4 (7.5, 9.3) | <0.001 |  |
| Q2 | 6.0 (5.5, 6.5) | 6.3 (5.8, 6.7) | 6.3 (5.9, 6.8) | 6.6 (6.2, 7.0) | 6.8 (6.4, 7.2) | 6.8 (6.3, 7.2) | 7.0 (6.5, 7.4) | 7.2 (6.8, 7.7) | <0.001 |  |
| Q3 | 6.5 (6.1, 7.0) | 7.2 (6.7, 7.6) | 7.3 (6.9, 7.7) | 6.9 (6.6, 7.3) | 6.7 (6.4, 7.0) | 7.0 (6.7, 7.3) | 7.4 (7.1, 7.7) | 8.5 (8.2, 8.9) | <0.001 |  |
| Q4 | 5.9 (5.3, 6.6) | 6.2 (5.6, 6.8) | 7.2 (6.8, 7.7) | 7.3 (6.9, 7.7) | 8.0 (7.6, 8.4) | 8.8 (8.4, 9.3) | 9.1 (8.6, 9.5) | 9.8 (9.4, 10.2) |  |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 23.4 (21.6, 25.3) | 22.3 (20.5, 24.2) | 20.7 (18.9, 22.5) | 21.5 (19.7, 23.3) | 20.9 (19.1, 22.6) | 22.0 (20.3, 23.8) | 20.5 (18.7, 22.2) | 19.7 (18.0, 21.5) | <0.001 |  |
| Q2 | 21.9 (20.8, 23.0) | 22.8 (21.7, 23.9) | 21.6 (20.7, 22.6) | 22.6 (21.6, 23.5) | 23.1 (22.2, 24.0) | 22.2 (21.2, 23.1) | 21.9 (20.9, 22.8) | 21.4 (20.4, 22.4) | 0.977 |  |
| Q3 | 21.7 (20.7, 22.8) | 22.5 (21.5, 23.5) | 22.6 (21.8, 23.5) | 23.2 (22.5, 24.0) | 22.9 (22.2, 23.7) | 22.7 (21.9, 23.4) | 23.2 (22.4, 23.9) | 24.7 (23.8, 25.5) | 0.013 |  |
| Q4 | 21.5 (20.2, 22.7) | 22.8 (21.6, 24.0) | 23.2 (22.3, 24.1) | 23.3 (22.5, 24.1) | 25.0 (24.2, 25.8) | 25.5 (24.7, 26.3) | 25.6 (24.7, 26.5) | 27.1 (26.2, 27.9) | <0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 93.6 (80.7, 106.4) | 98.9 (86.1, 111.7) | 102.1 (89.5, 114.7) | 107.3 (95.0, 119.6) | 105.3 (93.1, 117.4) | 120.3 (108.1, 132.5) | 125.3 (113.0, 137.6) | 133.8 (121.6, 145.9) | <0.001 |  |
| Q2 | 103.6 (94.3, 112.9) | 113.4 (104.3, 122.5) | 128.6 (120.2, 137.1) | 135.5 (127.6, 143.5) | 130.0 (122.1, 137.9) | 144.7 (136.7, 152.6) | 154.2 (146.0, 162.3) | 145.6 (136.8, 154.5) | <0.001 |  |
| Q3 | 141.0 (133.0, 149.0) | 140.5 (132.6, 148.5) | 163.7 (157.0, 170.4) | 162.1 (156.3, 168.0) | 157.7 (151.7, 163.6) | 149.6 (143.7, 155.6) | 153.0 (146.9, 159.0) | 162.0 (155.5, 168.5) | 0.118 |  |
| Q4 | 137.2 (127.8, 146.6) | 154.9 (146.0, 163.7) | 168.5 (161.7, 175.3) | 156.3 (150.6, 162.0) | 169.1 (163.1, 175.0) | 171.8 (165.5, 178.1) | 178.1 (171.4, 184.7) | 191.5 (185.1, 197.9) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 88.2 (75.9, 100.5) | 93.6 (81.4, 105.8) | 96.8 (84.8, 108.8) | 101.2 (89.4, 112.9) | 98.9 (87.3, 110.5) | 113.2 (101.6, 124.8) | 117.7 (106.0, 129.4) | 125.9 (114.3, 137.5) | <0.001 |  |
| Q2 | 97.2 (88.4, 106.0) | 106.3 (97.6, 115.0) | 121.3 (113.2, 129.3) | 127.8 (120.2, 135.4) | 122.4 (114.9, 129.8) | 136.0 (128.4, 143.5) | 145.2 (137.5, 152.9) | 137.4 (129.0, 145.8) | <0.001 |  |
| Q3 | 132.4 (124.8, 139.9) | 131.6 (124.0, 139.1) | 153.9 (147.5, 160.2) | 152.0 (146.5, 157.5) | 148.0 (142.3, 153.6) | 140.0 (134.4, 145.7) | 142.9 (137.2, 148.6) | 151.5 (145.4, 157.7) | 0.159 |  |
| Q4 | 128.8 (119.9, 137.8) | 145.0 (136.6, 153.3) | 158.0 (151.6, 164.4) | 146.2 (140.8, 151.6) | 158.2 (152.5, 163.8) | 160.7 (154.8, 166.7) | 166.8 (160.6, 173.1) | 179.1 (173.0, 185.1) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 5.3 (4.5, 6.1) | 5.3 (4.5, 6.1) | 5.3 (4.6, 6.1) | 6.1 (5.4, 6.9) | 6.4 (5.6, 7.2) | 7.1 (6.4, 7.9) | 7.6 (6.9, 8.4) | 8.0 (7.2, 8.7) | <0.001 |  |
| Q2 | 6.4 (5.8, 6.9) | 7.1 (6.5, 7.6) | 7.3 (6.8, 7.9) | 7.7 (7.2, 8.2) | 7.6 (7.2, 8.1) | 8.7 (8.2, 9.2) | 9.0 (8.5, 9.5) | 8.2 (7.7, 8.8) | <0.001 |  |
| Q3 | 8.6 (8.1, 9.1) | 8.9 (8.4, 9.5) | 9.9 (9.4, 10.3) | 10.1 (9.7, 10.5) | 9.7 (9.3, 10.1) | 9.6 (9.2, 10.0) | 10.0 (9.6, 10.4) | 10.5 (10.0, 10.9) | <0.001 |  |
| Q4 | 8.4 (7.8, 9.0) | 9.9 (9.3, 10.5) | 10.5 (10, 10.9) | 10.1 (9.7, 10.5) | 10.9 (10.5, 11.3) | 11.1 (10.7, 11.5) | 11.3 (10.8, 11.7) | 12.5 (12.1, 12.9) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Q1 | 109.3 (92.2, 126.3) | 125.9 (109.0, 142.8) | 130.4 (113.8, 147.0) | 127.3 (111.0, 143.6) | 122.7 (106.6, 138.9) | 133.0 (116.9, 149.1) | 132.1 (115.9, 148.3) | 142.0 (125.9, 158.1) | <0.001 |  |
| Q2 | 113.8 (104.2, 123.4) | 110.4 (101.0, 119.8) | 126.9 (118.2, 135.6) | 111.6 (103.4, 119.8) | 99.9 (91.9, 108.0) | 105.6 (97.4, 113.7) | 103.2 (94.9, 111.6) | 117.7 (108.6, 126.8) | 0.004 |  |
| Q3 | 139.3 (131.0, 147.6) | 121.9 (113.6, 130.1) | 126.2 (119.2, 133.2) | 112.1 (106.0, 118.2) | 108.8 (102.6, 115.0) | 111.9 (105.7, 118.1) | 111.9 (105.6, 118.1) | 111.2 (104.4, 118.0) | <0.001 |  |
| Q4 | 112.8 (104.1, 121.6) | 100.6 (92.4, 108.8) | 106.7 (100.5, 113) | 103.0 (97.7, 108.3) | 100.9 (95.4, 106.4) | 98.5 (92.6, 104.3) | 102.4 (96.3, 108.5) | 117.2 (111.3, 123.1) | 0.031 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 11**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among men stratified by education levels in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.040 |
| Junior school or below | 198.8 (193.1, 204.5) | 206.8 (201.0, 212.7) | 225.6 (219.9, 231.4) | 227.6 (221.7, 233.4) | 216.2 (210.1, 222.2) | 222.6 (216.4, 228.8) | 241.7 (235.6, 247.9) | 243.1 (237.1, 249.0) | <0.001 |  |
| Senior school | 222.0 (216.4, 227.6) | 237.1 (231.6, 242.6) | 253.1 (248.0, 258.2) | 251.7 (247.1, 256.4) | 245.0 (240.4, 249.5) | 254.2 (249.5, 258.9) | 260.9 (256.3, 265.4) | 273.9 (269.6, 278.2) | <0.001 |  |
| College or above | 249.4 (225.3, 273.6) | 266.6 (241.4, 291.9) | 283.7 (262.2, 305.2) | 273.5 (256.4, 290.6) | 287.8 (270.7, 304.9) | 286.9 (271.3, 302.5) | 285.5 (270.3, 300.7) | 314.3 (302.8, 325.7) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 85.8 (83.5, 88.1) | 87.5 (85.1, 89.8) | 92.0 (89.7, 94.3) | 92.0 (89.7, 94.3) | 87.9 (85.5, 90.3) | 87.0 (84.5, 89.5) | 90.0 (87.6, 92.5) | 90.7 (88.3, 93.1) | 0.055 |  |
| Senior school | 87.2 (85.3, 89.2) | 89.5 (87.6, 91.4) | 92.4 (90.6, 94.1) | 93.3 (91.7, 95.0) | 90.2 (88.6, 91.8) | 91.3 (89.7, 93.0) | 93.9 (92.3, 95.5) | 96.8 (95.3, 98.3) | <0.001 |  |
| College or above | 84.9 (77.0, 92.8) | 82.5 (74.2, 90.8) | 86.8 (79.8, 93.9) | 85.6 (80.0, 91.2) | 90.2 (84.6, 95.8) | 92.5 (87.4, 97.6) | 92.8 (87.8, 97.7) | 99.7 (96.0, 103.4) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 55.9 (54.2, 57.6) | 57.0 (55.2, 58.7) | 61.1 (59.3, 62.8) | 61.1 (59.3, 62.8) | 57.0 (55.2, 58.8) | 55.5 (53.6, 57.3) | 58.4 (56.6, 60.2) | 58.6 (56.8, 60.4) | 0.484 |  |
| Senior school | 55.6 (54.2, 57.0) | 56.4 (55.0, 57.8) | 59.6 (58.3, 60.8) | 59.7 (58.5, 60.8) | 57.0 (55.8, 58.1) | 57.1 (56.0, 58.3) | 59.3 (58.2, 60.5) | 61.0 (59.9, 62.1) | <0.001 |  |
| College or above | 53.6 (48.4, 58.8) | 50.0 (44.6, 55.4) | 52.5 (47.8, 57.1) | 51.0 (47.3, 54.7) | 53.7 (50.1, 57.4) | 55.5 (52.2, 58.8) | 57.3 (54.0, 60.5) | 59.3 (56.8, 61.7) | <0.001 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 6.3 (6.1, 6.6) | 6.8 (6.5, 7.1) | 7.1 (6.8, 7.4) | 7.2 (6.9, 7.5) | 7.2 (6.8, 7.5) | 7.3 (7.0, 7.7) | 7.8 (7.5, 8.1) | 8.3 (8.0, 8.6) | <0.001 |  |
| Senior school | 6.3 (6.0, 6.7) | 7.0 (6.7, 7.3) | 7.3 (7.0, 7.6) | 7.5 (7.3, 7.8) | 7.4 (7.1, 7.6) | 7.7 (7.4, 7.9) | 8.4 (8.1, 8.6) | 9.2 (8.9, 9.4) | <0.001 |  |
| College or above | 6.3 (4.9, 7.8) | 6.7 (5.2, 8.2) | 7.0 (5.7, 8.2) | 7.4 (6.4, 8.4) | 8.3 (7.3, 9.3) | 8.6 (7.7, 9.5) | 8.8 (7.9, 9.7) | 10.3 (9.7, 11.0) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.036 |
| Junior school or below | 23.6 (22.9, 24.3) | 23.6 (22.9, 24.4) | 23.8 (23.0, 24.5) | 23.8 (23.1, 24.6) | 23.8 (23.0, 24.6) | 24.3 (23.5, 25.1) | 23.9 (23.1, 24.7) | 23.9 (23.1, 24.6) | 0.364 |  |
| Senior school | 25.3 (24.7, 26.0) | 26.2 (25.6, 26.9) | 25.6 (25.0, 26.2) | 26.2 (25.6, 26.7) | 25.9 (25.4, 26.5) | 26.6 (26.0, 27.1) | 26.3 (25.7, 26.8) | 26.6 (26.1, 27.1) | 0.006 |  |
| College or above | 25.0 (21.9, 28.1) | 25.9 (22.7, 29.1) | 27.4 (24.7, 30.2) | 27.2 (25.0, 29.4) | 28.2 (26.0, 30.4) | 28.4 (26.4, 30.4) | 26.7 (24.8, 28.6) | 30.1 (28.7, 31.6) | <0.001 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 114.1 (109.4, 118.7) | 120.2 (115.4, 125.1) | 134.7 (129.9, 139.4) | 136.3 (131.4, 141.1) | 128.8 (123.8, 133.7) | 136.3 (131.2, 141.5) | 152.6 (147.5, 157.6) | 153.3 (148.4, 158.2) | <0.001 |  |
| Senior school | 135.4 (130.6, 140.3) | 148.1 (143.4, 152.8) | 161.5 (157.1, 165.9) | 159.1 (155.1, 163.1) | 155.3 (151.4, 159.3) | 163.7 (159.7, 167.8) | 167.6 (163.7, 171.5) | 178.1 (174.4, 181.8) | <0.001 |  |
| College or above | 165.4 (144.2, 186.7) | 185.3 (163.1, 207.6) | 198.1 (179.2, 217.0) | 188.5 (173.4, 203.5) | 198.3 (183.3, 213.3) | 194.6 (180.9, 208.3) | 193.0 (179.7, 206.3) | 215.8 (205.7, 225.8) | <0.001 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 107.5 (103.0, 111.9) | 113.2 (108.6, 117.8) | 127.3 (122.8, 131.8) | 128.6 (124.0, 133.2) | 121.2 (116.5, 125.9) | 128.2 (123.3, 133.1) | 143.5 (138.7, 148.3) | 144.4 (139.7, 149.0) | <0.001 |  |
| Senior school | 126.8 (122.2, 131.4) | 138.4 (134.0, 142.9) | 151.6 (147.5, 155.8) | 149.1 (145.3, 152.9) | 145.6 (141.9, 149.4) | 153.5 (149.6, 157.3) | 156.9 (153.2, 160.6) | 166.8 (163.3, 170.3) | <0.001 |  |
| College or above | 155.7 (135.7, 175.8) | 173.1 (152.1, 194.0) | 185.3 (167.5, 203.2) | 176.2 (162.0, 190.4) | 185.7 (171.5, 199.8) | 181.7 (168.8, 194.6) | 180.8 (168.3, 193.4) | 201.2 (191.7, 210.6) | <0.001 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 6.6 (6.3, 6.9) | 7.0 (6.7, 7.4) | 7.4 (7.1, 7.7) | 7.7 (7.4, 8.0) | 7.6 (7.2, 7.9) | 8.1 (7.8, 8.4) | 9.1 (8.7, 9.4) | 8.9 (8.6, 9.3) | <0.001 |  |
| Senior school | 8.6 (8.3, 9.0) | 9.7 (9.4, 10.0) | 9.9 (9.6, 10.2) | 10.0 (9.7, 10.2) | 9.7 (9.5, 10.0) | 10.3 (10.0, 10.5) | 10.7 (10.5, 11.0) | 11.3 (11.1, 11.6) | <0.001 |  |
| College or above | 9.7 (8.3, 11.2) | 12.3 (10.8, 13.8) | 12.8 (11.5, 14.1) | 12.3 (11.3, 13.3) | 12.7 (11.6, 13.7) | 12.9 (12.0, 13.9) | 12.2 (11.2, 13.1) | 14.6 (13.9, 15.3) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | 0.008 |
| Junior school or below | 150.8 (145.4, 156.2) | 150.0 (144.5, 155.5) | 156.7 (151.4, 162.0) | 145.5 (140.2, 150.8) | 141.2 (135.8, 146.7) | 146.3 (140.7, 152.0) | 138.8 (133.2, 144.4) | 147.5 (142.0, 153.1) | 0.003 |  |
| Senior school | 152.7 (147.7, 157.7) | 146.6 (141.7, 151.5) | 157.0 (152.5, 161.4) | 142.3 (138.2, 146.5) | 135.7 (131.6, 139.7) | 138.4 (134.3, 142.5) | 139.7 (135.6, 143.7) | 148.8 (144.9, 152.7) | <0.001 |  |
| College or above | 127.7 (110.2, 145.3) | 128.0 (109.6, 146.4) | 116.7 (101.0, 132.3) | 118.2 (105.8, 130.7) | 124.2 (111.7, 136.6) | 117.0 (105.6, 128.3) | 122.8 (111.8, 133.8) | 134.6 (126.3, 142.9) | 0.080 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 12**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among women stratified by education levels in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** |  |  |  |  |  |  |  |  |  | 0.107 |
| Junior school or below | 174.3 (170.3, 178.3) | 182.3 (178.3, 186.3) | 197.7 (193.7, 201.6) | 201.8 (197.9, 205.7) | 194.2 (190.3, 198.1) | 200.0 (196.0, 204.1) | 213.1 (209.1, 217.1) | 216.6 (212.7, 220.6) | <0.001 |  |
| Senior school | 199.8 (193.8, 205.7) | 213.1 (207.3, 218.9) | 225.7 (220.2, 231.2) | 221.1 (216.3, 226.0) | 221.5 (216.7, 226.2) | 227.1 (222.3, 231.8) | 233.8 (229.2, 238.4) | 246.3 (242.1, 250.5) | <0.001 |  |
| College or above | 236.2 (204.8, 267.6) | 248.0 (211.9, 284.2) | 233.8 (207.7, 259.9) | 243.8 (223.8, 263.8) | 248.5 (228.7, 268.2) | 259.0 (241.9, 276.1) | 267.0 (250.1, 283.9) | 281.3 (270.1, 292.5) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 76.0 (74.5, 77.6) | 77.7 (76.2, 79.3) | 79.8 (78.3, 81.4) | 80.0 (78.4, 81.5) | 77.5 (76.0, 79.0) | 75.7 (74.1, 77.3) | 79.3 (77.8, 80.9) | 80.4 (78.8, 81.9) | 0.029 |  |
| Senior school | 75.0 (73.1, 76.8) | 77.6 (75.8, 79.5) | 78.6 (76.8, 80.3) | 79.5 (78.0, 81.0) | 78.3 (76.8, 79.8) | 79.4 (77.9, 80.9) | 82.2 (80.7, 83.6) | 85.1 (83.7, 86.4) | <0.001 |  |
| College or above | 77.7 (67.0, 88.4) | 70.8 (58.4, 83.2) | 74.3 (65.4, 83.1) | 76.5 (69.7, 83.3) | 80.2 (73.5, 87.0) | 81.1 (75.3, 86.9) | 82.2 (76.4, 88.0) | 89.0 (85.2, 92.8) | <0.001 |  |
| Free choline (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 49.7 (48.5, 50.9) | 50.9 (49.7, 52.1) | 53.3 (52.1, 54.5) | 53.0 (51.9, 54.2) | 50.3 (49.1, 51.5) | 48.3 (47.1, 49.5) | 51.4 (50.2, 52.5) | 52.1 (51.0, 53.3) | 0.801 |  |
| Senior school | 47.5 (46.1, 48.8) | 48.7 (47.4, 50.0) | 50.4 (49.2, 51.7) | 50.2 (49.1, 51.3) | 48.8 (47.8, 49.9) | 49.1 (48.0, 50.2) | 52.1 (51.1, 53.1) | 53.4 (52.5, 54.3) | <0.001 |  |
| College or above | 47.5 (40.6, 54.5) | 38.7 (30.7, 46.7) | 44.6 (38.8, 50.3) | 45.4 (41.0, 49.9) | 46.9 (42.6, 51.3) | 47.9 (44.2, 51.7) | 49.5 (45.7, 53.2) | 52.1 (49.7, 54.6) | <0.001 |  |
| Phosphocholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 6.0 (5.8, 6.2) | 6.4 (6.1, 6.6) | 6.6 (6.3, 6.8) | 6.5 (6.2, 6.7) | 6.5 (6.3, 6.7) | 6.7 (6.5, 6.9) | 7.4 (7.1, 7.6) | 7.7 (7.5, 7.9) | <0.001 |  |
| Senior school | 5.7 (5.4, 6.0) | 6.2 (5.9, 6.5) | 6.4 (6.1, 6.7) | 6.6 (6.4, 6.9) | 6.8 (6.6, 7.1) | 7.3 (7.1, 7.6) | 7.6 (7.4, 7.9) | 8.4 (8.2, 8.6) | <0.001 |  |
| College or above | 5.6 (3.5, 7.8) | 5.6 (3.1, 8.1) | 6.0 (4.2, 7.8) | 7.1 (5.8, 8.5) | 8.2 (6.9, 9.5) | 8.2 (7.0, 9.3) | 8.2 (7.0, 9.3) | 9.3 (8.6, 10.1) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | 0.013 |
| Junior school or below | 20.3 (19.9, 20.8) | 20.5 (20.1, 21.0) | 20.0 (19.5, 20.4) | 20.5 (20.0, 20.9) | 20.7 (20.3, 21.1) | 20.7 (20.2, 21.1) | 20.6 (20.2, 21.1) | 20.6 (20.1, 21.0) | 0.158 |  |
| Senior school | 21.9 (21.2, 22.5) | 22.8 (22.2, 23.5) | 21.8 (21.2, 22.4) | 22.7 (22.2, 23.2) | 22.7 (22.2, 23.2) | 23.0 (22.5, 23.5) | 22.5 (22.0, 23.0) | 23.2 (22.8, 23.7) | 0.005 |  |
| College or above | 24.5 (20.5, 28.5) | 26.5 (21.9, 31.1) | 23.8 (20.5, 27.1) | 23.9 (21.4, 26.4) | 25.1 (22.6, 27.6) | 25.0 (22.8, 27.1) | 24.6 (22.4, 26.7) | 27.5 (26.1, 28.9) | 0.009 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 99.0 (95.7, 102.4) | 105.3 (101.9, 108.7) | 118.6 (115.3, 122.0) | 122.5 (119.2, 125.8) | 117.2 (113.9, 120.5) | 124.9 (121.5, 128.3) | 134.4 (131.1, 137.8) | 137.0 (133.7, 140.3) | <0.001 |  |
| Senior school | 125.4 (120.1, 130.6) | 135.9 (130.7, 141.1) | 147.7 (142.8, 152.7) | 142.1 (137.8, 146.4) | 143.6 (139.4, 147.8) | 148.3 (144.0, 152.5) | 152.1 (148.0, 156.2) | 162.0 (158.3, 165.8) | <0.001 |  |
| College or above | 159.7 (132.3, 187.0) | 178.5 (147.1, 209.9) | 160.4 (137.7, 183.0) | 168.0 (150.6, 185.5) | 169.1 (151.9, 186.3) | 178.7 (163.9, 193.6) | 185.5 (170.8, 200.2) | 193.4 (183.6, 203.1) | <0.001 |  |
| Phosphatidylcholine (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 93.3 (90.1, 96.5) | 99.1 (95.9, 102.3) | 112.2 (109.1, 115.4) | 115.7 (112.5, 118.8) | 110.6 (107.5, 113.7) | 117.8 (114.5, 121.0) | 126.6 (123.4, 129.8) | 129.1 (126.0, 132.3) | <0.001 |  |
| Senior school | 117.6 (112.6, 122.6) | 127.2 (122.3, 132.1) | 138.8 (134.1, 143.4) | 133.2 (129.2, 137.3) | 134.7 (130.7, 138.7) | 139.0 (135.0, 143.0) | 142.8 (138.9, 146.6) | 152.0 (148.5, 155.6) | <0.001 |  |
| College or above | 149.9 (124.0, 175.8) | 166.3 (136.5, 196.0) | 150.3 (128.8, 171.7) | 156.8 (140.3, 173.3) | 158.0 (141.7, 174.3) | 166.9 (152.8, 181) | 173.9 (160.0, 187.9) | 180.5 (171.3, 189.7) | <0.001 |  |
| Sphingomyelin (mg/d) |  |  |  |  |  |  |  |  |  | <0.001 |
| Junior school or below | 5.7 (5.5, 5.9) | 6.2 (6.0, 6.4) | 6.4 (6.2, 6.6) | 6.9 (6.6, 7.1) | 6.6 (6.4, 6.8) | 7.2 (7.0, 7.4) | 7.9 (7.7, 8.1) | 7.8 (7.6, 8.0) | <0.001 |  |
| Senior school | 7.8 (7.4, 8.1) | 8.7 (8.3, 9.0) | 9.0 (8.7, 9.3) | 8.8 (8.6, 9.1) | 8.9 (8.7, 9.2) | 9.3 (9.0, 9.5) | 9.4 (9.1, 9.6) | 10.0 (9.8, 10.2) | <0.001 |  |
| College or above | 9.8 (8.0, 11.5) | 12.2 (10.2, 14.3) | 10.1 (8.7, 11.6) | 11.3 (10.2, 12.4) | 11.1 (10.0, 12.2) | 11.8 (10.9, 12.8) | 11.5 (10.6, 12.5) | 12.9 (12.3, 13.5) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | 0.101 |
| Junior school or below | 128.5 (124.6, 132.3) | 126.5 (122.6, 130.4) | 132.0 (128.2, 135.7) | 124.4 (120.7, 128.1) | 118.4 (114.7, 122.1) | 121.7 (117.9, 125.5) | 119.0 (115.2, 122.8) | 126.8 (123.1, 130.6) | 0.002 |  |
| Senior school | 118.5 (113.3, 123.6) | 114.2 (109.2, 119.2) | 125.2 (120.5, 129.9) | 112.2 (108.0, 116.3) | 109.3 (105.2, 113.3) | 114.4 (110.4, 118.5) | 116.3 (112.3, 120.2) | 123.1 (119.4, 126.7) | 0.469 |  |
| College or above | 103.7 (76.6, 130.9) | 94.4 (65.6, 123.1) | 98.8 (76.2, 121.4) | 92.4 (75.3, 109.5) | 97.1 (80.4, 113.8) | 93.6 (78.5, 108.7) | 95.8 (81.0, 110.6) | 108.5 (97.4, 119.5) | 0.214 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), household income level (quartiles), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental Table 13**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among men stratified by household income levels in the China Health and Nutrition Survey 1991-2011.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** | |  |  |  |  |  |  |  |  | 0.022 |
| Low | 190.1 (179.4, 200.7) | 202.6 (192.0, 213.2) | 218.5 (208.3, 228.8) | 224.3 (214.2, 234.4) | 207.1 (196.9, 217.2) | 218.6 (208.4, 228.8) | 233.8 (223.7, 243.9) | 236.1 (226.7, 245.6) | <0.001 |  |
| Medium | 214.9 (206.3, 223.6) | 218.8 (210.2, 227.4) | 235.5 (227.1, 243.9) | 235.0 (226.9, 243.1) | 226.7 (218.6, 234.9) | 234.8 (226.6, 243.0) | 254.1 (246.1, 262.1) | 258.8 (251.5, 266.1) | <0.001 |  |
| High | 231.1 (222.9, 239.4) | 241.1 (232.7, 249.6) | 257.5 (249.4, 265.5) | 262.0 (254.3, 269.8) | 256.0 (248.2, 263.8) | 259.3 (251.4, 267.2) | 269.9 (262.2, 277.5) | 281.8 (274.9, 288.8) | <0.001 |  |
| Very high | 247.4 (239.2, 255.7) | 266.9 (258.6, 275.3) | 285.1 (277.1, 293.1) | 273.0 (265.4, 280.5) | 273.9 (266.3, 281.6) | 284.0 (276.3, 291.7) | 280.3 (272.8, 287.8) | 304.3 (297.4, 311.2) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 84.7 (80.2, 89.1) | 88.9 (84.5, 93.3) | 92.0 (87.7, 96.3) | 93.4 (89.2, 97.6) | 89.0 (84.7, 93.2) | 86.1 (81.8, 90.3) | 87.7 (83.5, 91.9) | 90.3 (86.4, 94.3) | 0.698 |  |
| Medium | 89.5 (86.2, 92.7) | 88.3 (85.1, 91.6) | 93.1 (90.0, 96.3) | 91.1 (88.0, 94.1) | 88.8 (85.7, 91.8) | 87.8 (84.8, 90.9) | 93.3 (90.3, 96.3) | 93.5 (90.8, 96.2) | 0.040 |  |
| High | 86.5 (83.7, 89.3) | 88.4 (85.5, 91.3) | 92.4 (89.7, 95.2) | 94.6 (91.9, 97.2) | 89.7 (87.1, 92.4) | 91.5 (88.8, 94.2) | 94.6 (92.0, 97.2) | 99.5 (97.2, 101.9) | <0.001 |  |
| Very high | 88.8 (86.0, 91.5) | 91.3 (88.5, 94.1) | 94.1 (91.5, 96.8) | 93.2 (90.7, 95.7) | 92.1 (89.6, 94.7) | 97.4 (94.8, 100.0) | 97.2 (94.7, 99.7) | 101.4 (99.1, 103.7) | <0.001 |  |
| Free choline (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 55.3 (51.9, 58.7) | 58.8 (55.5, 62.2) | 63.1 (59.8, 66.4) | 62.6 (59.3, 65.8) | 58.1 (54.9, 61.4) | 54.3 (51.1, 57.6) | 57.2 (54.0, 60.4) | 58.7 (55.7, 61.7) | 0.262 |  |
| Medium | 58.1 (55.7, 60.4) | 56.4 (54.0, 58.7) | 60.2 (57.8, 62.5) | 58.5 (56.3, 60.8) | 56.3 (54.0, 58.5) | 55.5 (53.2, 57.7) | 59.5 (57.3, 61.6) | 59.0 (57.0, 61.0) | 0.609 |  |
| High | 54.3 (52.2, 56.3) | 54.9 (52.8, 57.0) | 58.6 (56.6, 60.6) | 59.6 (57.7, 61.5) | 56.1 (54.2, 58.0) | 56.4 (54.5, 58.4) | 59.0 (57.1, 60.9) | 62.0 (60.3, 63.8) | <0.001 |  |
| Very high | 54.2 (52.3, 56.1) | 54.9 (53.0, 56.8) | 57.9 (56.1, 59.8) | 57.9 (56.2, 59.6) | 56.3 (54.5, 58.1) | 59.6 (57.9, 61.4) | 60.1 (58.4, 61.9) | 62.1 (60.5, 63.7) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 6.3 (5.6, 6.9) | 7.0 (6.4, 7.6) | 7.2 (6.7, 7.8) | 7.5 (7.0, 8.1) | 7.1 (6.5, 7.7) | 6.9 (6.3, 7.5) | 7.4 (6.8, 8.0) | 8.4 (7.8, 8.9) | <0.001 |  |
| Medium | 6.9 (6.4, 7.4) | 7.1 (6.6, 7.6) | 7.6 (7.1, 8.1) | 7.5 (7.0, 8.0) | 7.5 (7.0, 8.0) | 7.8 (7.3, 8.3) | 8.5 (8.1, 9.0) | 9.2 (8.8, 9.6) | <0.001 |  |
| High | 6.4 (6.0, 6.9) | 7.0 (6.6, 7.4) | 7.4 (7.0, 7.8) | 7.7 (7.3, 8.1) | 7.5 (7.1, 7.9) | 7.9 (7.5, 8.3) | 8.7 (8.3, 9.1) | 9.4 (9.0, 9.7) | <0.001 |  |
| Very high | 6.7 (6.3, 7.1) | 7.3 (6.9, 7.8) | 7.5 (7.1, 7.9) | 7.5 (7.2, 7.9) | 8.0 (7.6, 8.4) | 8.6 (8.2, 9.0) | 8.8 (8.4, 9.2) | 9.9 (9.6, 10.3) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 23.1 (21.8, 24.4) | 22.9 (21.6, 24.2) | 21.4 (20.2, 22.7) | 23.3 (22.0, 24.5) | 23.7 (22.5, 25.0) | 24.7 (23.4, 26.0) | 23.1 (21.8, 24.3) | 23.3 (22.1, 24.4) | 0.056 |  |
| Medium | 24.5 (23.4, 25.6) | 24.7 (23.6, 25.8) | 25.4 (24.4, 26.5) | 25.0 (24.0, 26.0) | 25.0 (24.0, 26.0) | 24.5 (23.5, 25.6) | 25.3 (24.3, 26.3) | 25.3 (24.4, 26.2) | 0.324 |  |
| High | 25.8 (24.8, 26.7) | 26.6 (25.6, 27.5) | 26.4 (25.5, 27.3) | 27.3 (26.4, 28.2) | 26.1 (25.2, 27.0) | 27.2 (26.3, 28.1) | 27.0 (26.1, 27.9) | 28.1 (27.3, 29.0) | <0.001 |  |
| Very high | 27.9 (26.9, 28.9) | 29.2 (28.1, 30.2) | 28.8 (27.8, 29.8) | 27.8 (26.9, 28.7) | 27.8 (26.8, 28.7) | 29.1 (28.2, 30.1) | 28.3 (27.3, 29.2) | 29.3 (28.5, 30.2) | 0.257 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 106.2 (97.8, 114.7) | 114.6 (106.2, 123) | 127.8 (119.6, 136) | 131.5 (123.4, 139.5) | 118.3 (110.2, 126.4) | 133.3 (125.2, 141.4) | 146.7 (138.6, 154.8) | 146.5 (139.0, 154.1) | <0.001 |  |
| Medium | 126.6 (119.3, 133.9) | 131.3 (123.9, 138.6) | 143.5 (136.3, 150.6) | 144.9 (138.0, 151.7) | 138.8 (131.9, 145.7) | 148.1 (141.1, 155.0) | 161.8 (155.0, 168.6) | 166.4 (160.2, 172.6) | <0.001 |  |
| High | 145.5 (138.3, 152.7) | 153.4 (146.1, 160.8) | 166.0 (159.0, 173.0) | 168.3 (161.5, 175.0) | 167.2 (160.4, 173.9) | 168.6 (161.7, 175.4) | 176.0 (169.3, 182.6) | 183.3 (177.3, 189.4) | <0.001 |  |
| Very high | 159.6 (152.4, 166.8) | 176.6 (169.3, 183.9) | 192.0 (185.0, 199.0) | 181.0 (174.4, 187.7) | 182.7 (176.0, 189.4) | 187.5 (180.7, 194.3) | 183.8 (177.2, 190.4) | 204.4 (198.3, 210.4) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 100.0 (92.0, 108.0) | 108.3 (100.3, 116.3) | 121.2 (113.5, 129.0) | 124.4 (116.7, 132.0) | 111.5 (103.8, 119.2) | 125.4 (117.7, 133.1) | 138.0 (130.3, 145.7) | 138.0 (130.8, 145.1) | <0.001 |  |
| Medium | 118.7 (111.8, 125.6) | 123.1 (116.1, 130.0) | 135.0 (128.2, 141.8) | 136.1 (129.6, 142.6) | 130.1 (123.6, 136.7) | 139.2 (132.7, 145.8) | 151.9 (145.5, 158.3) | 156.1 (150.2, 161.9) | <0.001 |  |
| High | 136.4 (129.6, 143.2) | 143.3 (136.4, 150.3) | 155.9 (149.3, 162.6) | 157.5 (151.1, 163.9) | 156.7 (150.3, 163.1) | 158.0 (151.5, 164.5) | 164.8 (158.5, 171.1) | 171.8 (166.1, 177.5) | <0.001 |  |
| Very high | 149.2 (142.4, 156.1) | 164.5 (157.5, 171.4) | 179.7 (173.1, 186.3) | 169.4 (163.1, 175.7) | 171.2 (164.8, 177.5) | 175.2 (168.7, 181.6) | 171.8 (165.6, 178.1) | 190.9 (185.2, 196.7) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 6.3 (5.7, 6.8) | 6.4 (5.8, 6.9) | 6.6 (6.1, 7.1) | 7.1 (6.6, 7.7) | 6.9 (6.3, 7.4) | 8.0 (7.4, 8.5) | 8.7 (8.2, 9.3) | 8.6 (8.1, 9.1) | <0.001 |  |
| Medium | 7.9 (7.4, 8.4) | 8.2 (7.7, 8.7) | 8.5 (8.0, 9.0) | 8.8 (8.3, 9.2) | 8.7 (8.2, 9.2) | 8.8 (8.4, 9.3) | 9.9 (9.5, 10.4) | 10.3 (9.9, 10.7) | <0.001 |  |
| High | 9.1 (8.6, 9.6) | 10.1 (9.6, 10.6) | 10.1 (9.6, 10.6) | 10.8 (10.3, 11.2) | 10.5 (10.0, 10.9) | 10.6 (10.1, 11.0) | 11.2 (10.7, 11.6) | 11.6 (11.2, 12.0) | <0.001 |  |
| Very high | 10.3 (9.9, 10.8) | 12.1 (11.6, 12.6) | 12.4 (11.9, 12.8) | 11.6 (11.2, 12.1) | 11.5 (11.1, 12.0) | 12.3 (11.9, 12.8) | 12.0 (11.5, 12.4) | 13.4 (13.0, 13.8) |  |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Low | 150.6 (139.9, 161.3) | 163.3 (152.7, 173.9) | 158.1 (147.8, 168.4) | 143.4 (133.3, 153.6) | 139.4 (129.2, 149.5) | 147.4 (137.3, 157.6) | 140.3 (130.1, 150.5) | 149.6 (139.9, 159.3) | 0.002 |  |
| Medium | 147.1 (138.6, 155.5) | 138.1 (129.8, 146.5) | 160.2 (152.1, 168.4) | 142.3 (134.5, 150.2) | 132.4 (124.5, 140.2) | 139.8 (132.0, 147.7) | 133.3 (125.5, 141.1) | 141.1 (133.8, 148.4) | 0.004 |  |
| High | 144.8 (137.7, 152.0) | 138.7 (131.4, 146.0) | 147.5 (140.6, 154.4) | 136.7 (130.0, 143.3) | 129.3 (122.7, 136.0) | 127.6 (120.9, 134.3) | 133.8 (127.2, 140.4) | 144.1 (138.0, 150.2) | 0.048 |  |
| Very high | 141.7 (135.2, 148.2) | 127.4 (120.8, 133.9) | 143.9 (137.7, 150.1) | 126.2 (120.4, 132.1) | 126.8 (120.8, 132.7) | 128.2 (122.2, 134.2) | 128.2 (122.4, 134.1) | 137.5 (132.1, 142.9) | 0.234 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models.

**Supplemental** **Table 14**. Adjusted mean (95% CI) intakes of dietary choline and betaine intake (mg/d) among women stratified by household income levels in the China Health and Nutrition Survey 1991-2011.1

|  | Survey year | | | | | | | | *P*-trend2 | *P*-interaction |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 | 2011 |
| **Total choline (mg/d)** | |  |  |  |  |  |  |  |  | 0.001 |
| Low | 170.0 ( 159.0 , 180.9 ) | 183.7 ( 172.8 , 194.6 ) | 195.3 ( 184.6 , 206.0 ) | 194.7 ( 184.1 , 205.2 ) | 185.7 ( 175.3 , 196.1 ) | 194.2 ( 183.8 , 204.6 ) | 208.4 ( 198.1 , 218.7 ) | 210.8 ( 201.1 , 220.5 ) | <0.001 |  |
| Medium | 184.2 ( 176.2 , 192.3 ) | 185.8 ( 177.8 , 193.9 ) | 203.4 ( 195.5 , 211.3 ) | 208.3 ( 200.8 , 215.9 ) | 200.4 ( 192.9 , 207.9 ) | 205.4 ( 197.9 , 212.8 ) | 227.6 ( 220.1 , 235.1 ) | 230.8 ( 224.2 , 237.4 ) | <0.001 |  |
| High | 207.2 ( 199.8 , 214.6 ) | 215.6 ( 208.1 , 223.1 ) | 225.7 ( 218.4 , 233.0 ) | 230.4 ( 223.4 , 237.3 ) | 230.2 ( 223.3 , 237.1 ) | 229.5 ( 222.6 , 236.3 ) | 238.3 ( 231.5 , 245.0 ) | 250.3 ( 244.3 , 256.3 ) | <0.001 |  |
| Very high | 224.1 ( 216.9 , 231.2 ) | 237.7 ( 230.5 , 244.9 ) | 255.3 ( 248.3 , 262.4 ) | 247.8 ( 241.2 , 254.3 ) | 249.1 ( 242.6 , 255.6 ) | 259.7 ( 253.2 , 266.1 ) | 255.2 ( 248.9 , 261.6 ) | 271.1 ( 265.4 , 276.7 ) | <0.001 |  |
| **Water-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 79.3 ( 74.9 , 83.8 ) | 83.2 ( 78.8 , 87.6 ) | 84.1 ( 79.7 , 88.4 ) | 83.7 ( 79.4 , 88.0 ) | 81.8 ( 77.6 , 86.0 ) | 78.3 ( 74.1 , 82.5 ) | 81.0 ( 76.8 , 85.2 ) | 82.9 ( 79.0, 86.9 ) | 0.761 |  |
| Medium | 76.0 ( 73.1 , 78.9 ) | 75.5 ( 72.6 , 78.4 ) | 79.9 ( 77.0, 82.8 ) | 77.9 ( 75.2 , 80.6 ) | 76.6 ( 73.9 , 79.3 ) | 74.8 ( 72.1 , 77.5 ) | 81.1 ( 78.4 , 83.8 ) | 82.6 ( 80.2 , 84.9 ) | <0.001 |  |
| High | 76.9 ( 74.4 , 79.4 ) | 79.8 ( 77.2 , 82.4 ) | 80.3 ( 77.8 , 82.8 ) | 82.8 ( 80.4 , 85.1 ) | 79.5 ( 77.1 , 81.8 ) | 79.8 ( 77.5 , 82.2 ) | 82.4 ( 80.1 , 84.7 ) | 87.1 ( 85.1 , 89.2 ) | <0.001 |  |
| Very high | 78.2 ( 75.9 , 80.5 ) | 80.0 ( 77.7 , 82.3 ) | 81.2 ( 78.9 , 83.4 ) | 82.4 ( 80.3 , 84.5 ) | 81.8 ( 79.8 , 83.9 ) | 85.5 ( 83.4 , 87.6 ) | 87.1 ( 85.1 , 89.2 ) | 89.4 ( 87.6 , 91.2 ) | <0.001 |  |
| Free choline (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 51.6 ( 48.2 , 55.0 ) | 54.8 ( 51.4 , 58.2 ) | 56.7 ( 53.4 , 60.0 ) | 55.2 ( 51.9 , 58.5 ) | 53.1 ( 49.8 , 56.3 ) | 48.8 ( 45.6 , 52.1 ) | 52.4 ( 49.1 , 55.6 ) | 53.6 ( 50.6 , 56.6 ) | 0.076 |  |
| Medium | 48.7 ( 46.5 , 50.9 ) | 48.0 ( 45.8 , 50.2 ) | 52.3 ( 50.2 , 54.5 ) | 50.1 ( 48.0, 52.1 ) | 48.2 ( 46.2 , 50.3 ) | 47.2 ( 45.2 , 49.2 ) | 51.6 ( 49.5 , 53.6 ) | 52.5 ( 50.7 , 54.3 ) | 0.009 |  |
| High | 48.2 ( 46.4 , 50.1 ) | 49.6 ( 47.8 , 51.4 ) | 51.0 ( 49.3 , 52.8 ) | 52.1 ( 50.4 , 53.8 ) | 49.7 ( 48.0, 51.4 ) | 49.4 ( 47.8 , 51.1 ) | 51.6 ( 50.0, 53.3 ) | 54.5 ( 53.0, 55.9 ) | <0.001 |  |
| Very high | 47.8 ( 46.2 , 49.4 ) | 48.2 ( 46.6 , 49.8 ) | 49.9 ( 48.3 , 51.4 ) | 50.9 ( 49.5 , 52.4 ) | 49.5 ( 48.0 , 50.9 ) | 51.7 ( 50.2 , 53.2 ) | 53.8 ( 52.4 , 55.3 ) | 54.5 ( 53.3 , 55.8 ) | <0.001 |  |
| Phosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 6.3 ( 5.6 , 6.9 ) | 6.7 ( 6.1 , 7.3 ) | 6.7 ( 6.1 , 7.3 ) | 6.8 ( 6.2 , 7.4 ) | 6.5 ( 5.9 , 7.1 ) | 6.6 ( 6.0, 7.2 ) | 7.1 ( 6.5 , 7.7 ) | 7.7 ( 7.2 , 8.3 ) | <0.001 |  |
| Medium | 5.9 ( 5.5 , 6.4 ) | 6.2 ( 5.7 , 6.6 ) | 6.7 ( 6.3 , 7.2 ) | 6.4 ( 6.0, 6.8 ) | 6.7 ( 6.3 , 7.1 ) | 6.8 ( 6.4 , 7.2 ) | 7.6 ( 7.2 , 8.0 ) | 8.3 ( 7.9 , 8.6 ) | <0.001 |  |
| High | 5.9 ( 5.5 , 6.3 ) | 6.6 ( 6.2 , 7.0 ) | 6.7 ( 6.3 , 7.1 ) | 7.0 ( 6.6 , 7.4 ) | 6.9 ( 6.5 , 7.2 ) | 7.4 ( 7.0 , 7.7 ) | 7.8 ( 7.5 , 8.2 ) | 8.6 ( 8.3 , 8.9 ) | <0.001 |  |
| Very high | 6.2 ( 5.9 , 6.6 ) | 6.5 ( 6.2 , 6.9 ) | 6.7 ( 6.3 , 7.0 ) | 6.9 ( 6.5 , 7.2 ) | 7.5 ( 7.1 , 7.8 ) | 8.3 ( 7.9 , 8.6 ) | 8.4 ( 8.1 , 8.7 ) | 8.9 ( 8.7 , 9.2 ) | <0.001 |  |
| Glycerophosphocholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 21.5 ( 20.2 , 22.8 ) | 21.7 ( 20.4 , 22.9 ) | 20.6 ( 19.3 , 21.9 ) | 21.7 ( 20.4 , 22.9 ) | 22.2 ( 21.0 , 23.4 ) | 22.9 ( 21.6 , 24.1 ) | 21.6 ( 20.3 , 22.8 ) | 21.6 ( 20.4 , 22.7 ) | 0.190 |  |
| Medium | 21.3 ( 20.5 , 22.2 ) | 21.2 ( 20.4 , 22.0 ) | 20.9 ( 20.1 , 21.7 ) | 21.4 ( 20.6 , 22.2 ) | 21.7 ( 20.9 , 22.4 ) | 20.8 ( 20.0 , 21.6 ) | 21.9 ( 21.2 , 22.7 ) | 21.8 ( 21.1 , 22.5 ) | 0.079 |  |
| High | 22.8 ( 22.0, 23.6 ) | 23.7 ( 22.9 , 24.5 ) | 22.6 ( 21.8 , 23.4 ) | 23.6 ( 22.9 , 24.4 ) | 23.0 ( 22.2 , 23.7 ) | 23.1 ( 22.3 , 23.8 ) | 23.0 ( 22.3 , 23.7 ) | 24.1 ( 23.4 , 24.7 ) | 0.183 |  |
| Very high | 23.8 ( 23.0 , 24.6 ) | 24.9 ( 24.1 , 25.7 ) | 24.3 ( 23.5 , 25.1 ) | 24.3 ( 23.5 , 25.0 ) | 24.5 ( 23.8 , 25.3 ) | 25.2 ( 24.5 , 26.0) | 24.6 ( 23.9 , 25.4 ) | 25.8 ( 25.1 , 26.4 ) | 0.003 |  |
| **Lipid-soluble choline (mg/d)** | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 91.3 ( 82.3 , 100.3 ) | 101.2 ( 92.3 , 110.2 ) | 112.0 ( 103.2 , 120.9 ) | 111.5 ( 102.8 , 120.2 ) | 104.2 ( 95.6 , 112.8 ) | 116.5 ( 107.9 , 125.0 ) | 127.9 ( 119.4 , 136.4 ) | 128.6 ( 120.6 , 136.6 ) | <0.001 |  |
| Medium | 109.1 ( 102.2 , 116.1 ) | 111.0 ( 104.1 , 118.0 ) | 124.5 ( 117.6 , 131.3 ) | 131.4 ( 124.8 , 137.9 ) | 124.6 ( 118.1 , 131.0 ) | 131.4 ( 125.0 , 137.8 ) | 147.4 ( 140.9 , 153.8 ) | 149.2 ( 143.5 , 154.9 ) | <0.001 |  |
| High | 130.9 ( 124.4 , 137.5 ) | 136.3 ( 129.6 , 142.9 ) | 146.0 ( 139.6 , 152.5 ) | 148.2 ( 142.1 , 154.3 ) | 151.3 ( 145.3 , 157.4 ) | 150.2 ( 144.2 , 156.2 ) | 156.5 ( 150.6 , 162.4 ) | 164.1 ( 158.8 , 169.4 ) | <0.001 |  |
| Very high | 146.7 ( 140.3 , 153.0 ) | 158.4 ( 152.1 , 164.8 ) | 175.2 ( 168.9 , 181.4 ) | 166.4 ( 160.6 , 172.2 ) | 168.2 ( 162.5 , 173.9 ) | 175.1 ( 169.4 , 180.8 ) | 168.8 ( 163.2 , 174.4 ) | 182.7 ( 177.7 , 187.7 ) | <0.001 |  |
| Phosphatidylcholine (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 86.0 ( 77.4 , 94.6 ) | 95.4 ( 86.8 , 103.9 ) | 106 ( 97.6 , 114.5 ) | 105.2 ( 96.9 , 113.5 ) | 98.1 ( 89.9 , 106.3 ) | 109.3 ( 101.2 , 117.5 ) | 120.3 ( 112.2 , 128.3 ) | 121.0 ( 113.4 , 128.6 ) | <0.001 |  |
| Medium | 102.3 ( 95.7 , 108.9 ) | 104.4 ( 97.8 , 111.0 ) | 117.4 ( 110.9 , 123.9 ) | 123.6 ( 117.5 , 129.8 ) | 117.0 ( 110.9 , 123.2 ) | 123.8 ( 117.7 , 129.9 ) | 138.6 ( 132.5 , 144.7 ) | 140.4 ( 134.9 , 145.8 ) | <0.001 |  |
| High | 122.7 ( 116.5 , 128.9 ) | 127.3 ( 121.0 , 133.6 ) | 137.2 ( 131.1 , 143.3 ) | 138.7 ( 132.9 , 144.5 ) | 142.0 ( 136.3 , 147.8 ) | 140.9 ( 135.2 , 146.7 ) | 146.8 ( 141.2 , 152.4 ) | 154.1 ( 149.0 , 159.1 ) | <0.001 |  |
| Very high | 137.3 ( 131.3 , 143.3 ) | 147.9 ( 141.8 , 153.9 ) | 164.1 ( 158.2 , 170.0) | 155.9 ( 150.5 , 161.4 ) | 157.7 ( 152.3 , 163.1 ) | 163.9 ( 158.4 , 169.3 ) | 158.2 ( 152.9 , 163.5 ) | 171.1 ( 166.4 , 175.9 ) | <0.001 |  |
| Sphingomyelin (mg/d) | |  |  |  |  |  |  |  |  | <0.001 |
| Low | 5.3 ( 4.7 , 5.9 ) | 5.9 ( 5.3 , 6.5 ) | 6.0 ( 5.5 , 6.6 ) | 6.3 ( 5.8 , 6.8 ) | 6.1 ( 5.6 , 6.7 ) | 7.2 ( 6.6 , 7.7 ) | 7.7 ( 7.2 , 8.2 ) | 7.6 ( 7.1 , 8.1 ) | <0.001 |  |
| Medium | 6.8 ( 6.4 , 7.3 ) | 6.7 ( 6.2 , 7.1 ) | 7.1 ( 6.7 , 7.5 ) | 7.7 ( 7.3 , 8.1 ) | 7.5 ( 7.1 , 8.0) | 7.6 ( 7.2 , 8.1 ) | 8.8 ( 8.4 , 9.2 ) | 8.8 ( 8.5 , 9.2 ) | <0.001 |  |
| High | 8.3 ( 7.9 , 8.7 ) | 9.0 ( 8.6 , 9.4 ) | 8.9 ( 8.5 , 9.3 ) | 9.5 ( 9.1 , 9.9 ) | 9.3 ( 8.9 , 9.7 ) | 9.3 ( 8.9 , 9.7 ) | 9.7 ( 9.3 , 10.1 ) | 10.0 ( 9.6 , 10.3 ) | <0.001 |  |
| Very high | 9.4 ( 8.9 , 9.8 ) | 10.6 ( 10.2 , 11.0) | 11.1 ( 10.7 , 11.5 ) | 10.4 ( 10.1 , 10.8 ) | 10.5 ( 10.1 , 10.8 ) | 11.2 ( 10.9 , 11.6 ) | 10.6 ( 10.2 , 10.9 ) | 11.6 ( 11.3 , 11.9 ) | <0.001 |  |
| **Betaine (mg/d)** |  |  |  |  |  |  |  |  |  | <0.001 |
| Low | 123.7 ( 113.2 , 134.2 ) | 135.4 ( 125.0 , 145.8 ) | 135.0 ( 124.7 , 145.3 ) | 119.3 ( 109.2 , 129.4 ) | 116.4 ( 106.4 , 126.3 ) | 123.3 ( 113.3 , 133.2 ) | 119.5 ( 109.6 , 129.4 ) | 126.5 ( 117.0 , 136.0 ) | 0.025 |  |
| Medium | 124.0 ( 116.3 , 131.7 ) | 120.9 ( 113.3 , 128.5 ) | 132.1 ( 124.6 , 139.5 ) | 119.4 ( 112.3 , 126.5 ) | 111.4 ( 104.4 , 118.4 ) | 113.1 ( 106.2 , 120.1 ) | 113.2 ( 106.1 , 120.2 ) | 123.1 ( 116.7 , 129.5 ) | 0.009 |  |
| High | 118.3 ( 111.6 , 125.0 ) | 109.9 ( 103.1 , 116.6 ) | 118.6 ( 112.0 , 125.1 ) | 110.7 ( 104.5 , 116.9 ) | 106.5 ( 100.4 , 112.6 ) | 105.3 ( 99.2 , 111.4 ) | 112.5 ( 106.4 , 118.5 ) | 120.5 ( 115.1 , 126.0 ) | 0.821 |  |
| Very high | 117.1 ( 110.6 , 123.7 ) | 106.2 ( 99.6 , 112.7 ) | 117.3 ( 110.9 , 123.6 ) | 105.2 ( 99.4 , 111.1 ) | 104.9 ( 99.2 , 110.7 ) | 110.5 ( 104.8 , 116.3 ) | 108.5 ( 102.8 , 114.2 ) | 118.3 ( 113.2 , 123.5 ) | 0.725 |  |

1 Adjusted for age, urbanization index, total energy intake, BMI (<18.5, 18.5-23.9, 24.0-27.9, ≥28.0 kg/m2), education level (junior school or below, senior school, college or higher), and geographic region (southern, northern).

2 Tests for linear trends were conducted using linear mixed-effects regression models

Adult participants (≥18y) from CHNS 1991-2011 (n=25251)

Participants with complete records

(n=23733)

Participants free from the conditions that may influence dietary intake (n=23587)

Eligible participants (n=23467)

Excluded if record information was incomplete (n=1518)

Excluded if participants who were pregnant or breastfeeding (n=146)

Excluded if energy were implausible or dietary information was unavailable (n=120)

**Supplemental Figure 1**. The flow chart of sample selection from the China Health and Nutrition Survey.



**Supplemental** **Figure 2**. Numbers of participants according to the times of dietary surveys in the China Health and Nutrition Survey 1991-2011.



**Supplemental** **Figure 3**. Trends in the proportion of adult participants meeting the adequate intake (AI) for total choline among men (A) and women (B) in the different age groups in the China Health and Nutrition Survey 1991-2011.

 **Supplemental** **Figure 4**. Contribution of individual choline forms to dietary total choline intake among men (A) and women (B) in the China Health and Nutrition Survey 1991-2011.