**Supplemental Table 1 Sensitivity analysis before and after interpolation**

| Variables | Before (n=4920) | After (n=4920) | *P* |
| --- | --- | --- | --- |
| Education level, n (%) |  |  | 1.000 |
| Less than 9th grade | 567 (11.59) | 574 (11.67) |  |
| 9-11th grade | 645 (13.18) | 648 (13.17) |  |
| High school grade/GED or equivalent | 1256 (25.67) | 1262 (25.65) |  |
| Some college or AA degree | 1459 (29.82) | 1467 (29.82) |  |
| College graduate or above | 965 (19.73) | 969 (19.70) |  |
| Marital status, n (%) |  |  | 1.000 |
| Married | 2440 (49.78) | 2451 (49.82) |  |
| Widowed | 1330 (27.13) | 1333 (27.09) |  |
| Divorced | 687 (14.01) | 688 (13.98) |  |
| Separated | 105 (2.14) | 105 (2.13) |  |
| Never married | 242 (4.94) | 245 (4.98) |  |
| Living with partner | 98 (2.00) | 98 (1.99) |  |
| Family PIR, ratio, M (Q1, Q3) | 2.27 (1.24, 4.29) | 2.27 (1.24, 4.26) | 0.899 |
| BMI, kg/m2, Mean ± SD | 29.01 ± 6.24 | 29.01 ± 6.24 | 0.991 |
| Smoke status, n (%) |  |  | 0.955 |
| Yes | 1949 (39.79) | 1955 (39.74) |  |
| No | 2949 (60.21) | 2965 (60.26) |  |
| History of fracture, n (%) |  |  | 0.974 |
| Yes | 88 (1.80) | 88 (1.79) |  |
| No | 4808 (98.20) | 4832 (98.21) |  |
| Parental history of fracture, n (%) |  |  | 0.922 |
| No | 4087 (88.64) | 4364 (88.70) |  |
| Yes | 524 (11.36) | 556 (11.30) |  |
| Cotinine, ng/mL, M (Q1, Q3) | 0.03 (0.01, 0.18) | 0.03 (0.01, 0.18) | 0.811 |
| Iron, μmol/L, M (Q1, Q3) | 13.80 (10.90, 17.40) | 13.80 (10.90, 17.40) | 0.952 |
| 25[OH]D, nmol/L, M (Q1, Q3) | 8.45 (2.85, 25.40) | 7.85 (2.80, 24.53) | 0.221 |

Note: GED=general educational development; AA=associate of arts; PIR=poverty to income ratio; BMI=body mass index; 25(OH)D=25-hydroxyvitamin D.

**Supplemental Table 2 Screening of confounding factors related to three outcome variables**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variables | Osteoporosis | | Total femur BMD | | Femur neck BMD | |
| OR (95%CI) | *P* | Beta (95%CI) | *P* | Beta (95%CI) | *P* |
| Age | 3.03 (2.61-3.52) | <0.001 | -0.31 (-0.35, -0.28) | <0.001 | -0.03 (-0.03, -0.03) | <0.001 |
| Race/ethnicity |  |  |  |  |  |  |
| Mexican American | Ref |  | Ref |  | Ref |  |
| Other Hispanic | 1.78 (1.01-3.16) | 0.047 | -0.13 (-0.29, 0.02) | 0.095 | -0.08 (-0.24, 0.08) | 0.345 |
| Non-Hispanic White | 2.41 (1.55-3.75) | <0.001 | -0.28 (-0.40, -0.15) | <0.001 | -0.24 (-0.36, -0.12) | <0.001 |
| Non-Hispanic Black | 0.97 (0.55-1.73) | 0.920 | 0.27 (0.13, 0.41) | <0.001 | 0.55 (0.40, 0.69) | <0.001 |
| Other Race - Including Multi-Racial | 2.65 (1.45-4.86) | 0.002 | -0.41 (-0.56, -0.26) | <0.001 | -0.41 (-0.57, -0.26) | <0.001 |
| Education level |  |  |  |  |  |  |
| Less than 9th grade | Ref |  | Ref |  | Ref |  |
| 9-11th grade | 0.92 (0.59-1.44) | 0.718 | 0.02 (-0.16, 0.19) | 0.866 | 0.08 (-0.12, 0.28) | 0.416 |
| High school grade/GED or equivalent | 0.61 (0.39-0.96) | 0.032 | 0.12 (-0.03, 0.28) | 0.124 | 0.12 (-0.04, 0.28) | 0.136 |
| Some college or AA degree | 0.51 (0.34-0.77) | 0.002 | 0.2 (0.05, 0.36) | 0.008 | 0.15 (-0.01, 0.31) | 0.065 |
| College graduate or above | 0.50 (0.32-0.80) | 0.004 | 0.18 (0.03, 0.33) | 0.02 | 0.09 (-0.07, 0.25) | 0.266 |
| Marital status |  |  |  |  |  |  |
| Married | Ref |  | Ref |  | Ref |  |
| Widowed | 2.73 (1.96-3.82) | <0.001 | -0.4 (-0.49, -0.31) | <0.001 | -0.37 (-0.46, -0.28) | <0.001 |
| Divorced | 1.13 (0.75-1.68) | 0.559 | -0.01 (-0.12, 0.10) | 0.862 | 0.02 (-0.09, 0.13) | 0.766 |
| Separated | 0.60 (0.24-1.51) | 0.274 | 0.04 (-0.23, 0.31) | 0.767 | 0.24 (-0.05, 0.53) | 0.102 |
| Never married | 0.94 (0.57-1.55) | 0.798 | 0.17 (0.01, 0.34) | 0.041 | 0.28 (0.10, 0.45) | 0.002 |
| Living with partner | 0.23 (0.07-0.79) | 0.02 | -0.06 (-0.28, 0.16) | 0.587 | -0.02 (-0.27, 0.22) | 0.860 |
| Family PIR | 0.70 (0.60-0.82) | <0.001 | 0.08 (0.04, 0.12) | <0.001 | 0.03 (0.01, 0.06) | 0.010 |
| BMI | 0.38 (0.31-0.47) | <0.001 | 0.47 (0.43, 0.50) | <0.001 | 0.07 (0.06, 0.07) | <0.001 |
| Physical activity | 0.80 (0.31-2.03) | 0.629 | 0.02 (-0.02, 0.06) | 0.302 | 0.03 (-0.01, 0.06) | 0.298 |
| Smoke status |  |  |  |  |  |  |
| Yes | Ref |  | Ref |  | Ref |  |
| No | 0.84 (0.66-1.08) | 0.169 | 0.06 (-0.02, 0.14) | 0.169 | 0.02 (-0.06, 0.09) | 0.611 |
| History of fracture | |  |  |  |  |  |
| Yes | Ref |  | Ref |  | Ref |  |
| No | 0.17 (0.10-0.30) | <0.001 | 0.67 (0.32, 1.01) | <0.001 | 0.42 (0.04, 0.79) | 0.029 |
| History of diabetes | |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 0.90 (0.65-1.24) | 0.505 | 0.31 (0.21, 0.42) | <0.001 | 0.28 (0.18, 0.38) | <0.001 |
| History of hypertension |  |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 2.38 (1.80-3.13) | <0.001 | -0.03 (-0.12, 0.05) | 0.474 | -0.04 (-0.13, 0.04) | 0.324 |
| Parental history of fracture | |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 1.18 (0.87-1.59) | 0.278 | -0.19 (-0.29, -0.10) | <0.001 | -0.26 (-0.36, -0.16) | <0.001 |
| Cotinine | 1.18 (1.07-1.31) | 0.001 | -0.08 (-0.12, -0.05) | <0.001 | -0.03 (-0.07, 0.00) | 0.031 |
| Lead | 1.09 (1.01-1.17) | 0.018 | -0.10 (-0.13, -0.06) | <0.001 | -0.08 (-0.11, -0.04) | <0.001 |
| Iron | 1.01 (0.99-1.03) | 0.509 | -0.01 (-0.02, -0.00) | 0.005 | -0.01 (-0.02, -0.01) | <0.001 |
| 25(OH)D | 1.14 (0.96-1.35) | 0.129 | -0.07 (-0.13, -0.01) | 0.022 | -0.05 (-0.11, 0.00) | 0.007 |
| Calcium | 1.00 (0.90-1.12) | 0.948 | -0.03 (-0.07, -0.00) | 0.042 | -0.05 (-0.08, -0.01) | 0.007 |
| Using of female hormone |  |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 0.26 (0.11-0.59) | 0.002 | 0.34 (0.21, 0.47) | <0.001 | 0.28 (0.15, 0.41) | <0.001 |
| Glucocorticoid |  |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 0.93 (0.58-1.47) | 0.744 | 0.1 (-0.03, 0.22) | 0.123 | 0.09 (-0.06, 0.23) | 0.222 |
| Anti-osteoporosis therapy |  |  |  |  |  |  |
| No | Ref |  | Ref |  | Ref |  |
| Yes | 2.71 (1.88-3.89) | <0.001 | -0.63 (-0.75, -0.51) | <0.001 | -0.66 (-0.76, -0.57) | <0.001 |
| Energy | 0.80 (0.71-0.90) | <0.001 | 0.08 (0.04, 0.12) | <0.001 | 0.07 (0.04, 0.11) | <0.001 |
| Protein | 0.70 (0.60-0.82) | <0.001 | 0.11 (0.07, 0.15) | <0.001 | 0.09 (0.05, 0.13) | <0.001 |
| Carbohydrate | 0.94 (0.81-1.09) | 0.391 | 0.03 (-0.01, 0.07) | 0.144 | 0.03 (-0.01, 0.06) | 0.215 |
| Total fat | 0.84 (0.72-0.97) | 0.019 | 0.08 (0.04, 0.12) | <0.001 | 0.06 (0.03, 0.10) | 0.001 |
| Vegetable intake, n (%) |  |  |  |  |  |  |
| <2.5 | Ref |  | Ref |  | Ref |  |
| >2.5 | 0.59 (0.33-1.06) | 0.077 | 0.11 (0.00, 0.23) | 0.049 | 0.05 (-0.06, 0.16) | 0.348 |
| Unknown | 1.32 (0.97-1.79) | 0.074 | -0.12 (-0.22, -0.03) | 0.010 | -0.2 (-0.29, -0.10) | <.001 |
| Grain intake, n (%) |  |  |  |  |  |  |
| <3.5 | Ref |  | Ref |  | Ref |  |
| >3.5 | 0.51 (0.23-1.16) | 0.106 | 0.09 (-0.21, 0.39) | 0.540 | 0.06 (-0.18, 0.30) | 0.600 |
| Unknown | 0.59 (0.25-1.40) | 0.227 | 0.07 (-0.23, 0.38) | 0.626 | 0.03 (-0.21, 0.28) | 0.787 |

Note: GED=general educational development; AA=associate of arts; PIR=poverty to income ratio; BMI=body mass index; MET= metabolic equivalent; Cd= cadmium; 25(OH)D=25-hydroxyvitamin D; DAQS=dietary antioxidant quality score; BMD= bone mineral density; OR=odds ratio; CI=confidence interval.

**Supplemental Table 3 Characteristics comparison between low Cd and high Cd groups**

| Variables | Low Cd group (n=3684) | High Cd group (n=1236) | Statistics | *P* |
| --- | --- | --- | --- | --- |
| Age, years, Mean (S.E) | 61.88 (0.28) | 61.17 (0.42) | t=1.49 | 0.140 |
| Race/ethnicity, n (%) |  |  | χ2=54.164 | <0.001 |
| Mexican American | 564 (5.43) | 105 (3.34) |  |  |
| Other Hispanic | 399 (4.66) | 67 (2.20) |  |  |
| Non-Hispanic White | 1792 (76.45) | 674 (75.21) |  |  |
| Non-Hispanic Black | 718 (8.72) | 251 (10.42) |  |  |
| Other Race-Including Multi-Racial | 211 (4.74) | 139 (8.82) |  |  |
| Education level, n (%) |  |  | χ2=61.940 | <0.001 |
| Less than 9th grade | 461 (5.61) | 113 (5.37) |  |  |
| 9-11th grade | 420 (8.77) | 229 (15.88) |  |  |
| High school grade/GED or equivalent | 907 (26.36) | 359 (33.98) |  |  |
| Some college or AA degree | 1101 (30.93) | 361 (28.95) |  |  |
| College graduate or above | 795 (28.33) | 174 (15.82) |  |  |
| Marital status, n (%) |  |  | χ2=45.711 | <0.001 |
| Married | 1932 (60.56) | 516 (48.00) |  |  |
| Widowed | 968 (20.77) | 366 (23.43) |  |  |
| Divorced | 469 (11.86) | 221 (18.75) |  |  |
| Separated | 73 (1.18) | 33 (1.94) |  |  |
| Never married | 181 (4.15) | 63 (4.29) |  |  |
| Living with partner | 61 (1.49) | 37 (3.60) |  |  |
| Family PIR, ratio, Mean (S.E) | 3.29 (0.04) | 2.68 (0.08) | t=8.33 | <0.001 |
| BMI, kg/m2, Mean (S.E) | 29.01 (0.15) | 27.35 (0.23) | t=5.61 | <0.001 |
| Physical activity, MET/minutes, Mean (S.E) | 756.25 (74.27) | 704.62 (62.45) | t=0.56 | 0.577 |
| Smoking status, n (%) |  |  | χ2=318.653 | <0.001 |
| Yes | 1035 (32.21) | 922 (79.54) |  |  |
| No | 2649 (67.79) | 314 (20.46) |  |  |
| History of fracture, n (%) |  |  | χ2=2.701 | 0.100 |
| Yes | 60 (1.43) | 29 (2.38) |  |  |
| No | 3624 (98.57) | 1207 (97.62) |  |  |
| History of diabetes, n (%) |  |  | χ2=4.225 | 0.040 |
| No | 2803 (82.24) | 1000 (85.29) |  |  |
| Yes | 881 (17.76) | 236 (14.71) |  |  |
| History of hypertension, n (%) |  |  | χ2=3.094 | 0.079 |
| No | 994 (31.09) | 293 (27.56) |  |  |
| Yes | 2690 (68.91) | 943 (72.44) |  |  |
| Parental history of fracture, n (%) |  |  | χ2=0.349 | 0.555 |
| No | 3266 (88.18) | 1105 (89.14) |  |  |
| Yes | 418 (11.82) | 131 (10.86) |  |  |
| Cotinine, ng/mL, Mean (S.E) | 8.04 (1.11) | 149.86 (7.10) | t=-19.89 | <0.001 |
| Cadmium, μg/L, Mean (S.E) | 0.33 (0.00) | 1.24 (0.04) | t=-24.06 | <0.001 |
| Lead, μg/dL Mean (S.E) | 1.48 (0.02) | 1.99 (0.04) | t=-10.25 | <0.001 |
| Iron, μmol/L, Mean (S.E) | 14.69 (0.12) | 15.00 (0.22) | t=-1.40 | 0.164 |
| 25[OH]D, nmol/L Mean (S.E) | 8.04 (0.30) | 7.66 (0.41) | t=0.76 | 0.452 |
| Calcium, mg/day, Mean (S.E) | 1136.40 (16.68) | 987.65 (27.29) | t=5.36 | <0.001 |
| Using of female hormone, n (%) |  |  | χ2=6.692 | 0.010 |
| No | 3431 (89.12) | 1165 (93.22) |  |  |
| Yes | 253 (10.88) | 71 (6.78) |  |  |
| Glucocorticoid, n (%) |  |  | χ2=0.006 | 0.937 |
| No | 3588 (97.54) | 1202 (97.48) |  |  |
| Yes | 96 (2.46) | 34 (2.52) |  |  |
| Anti-osteoporosis therapy, n (%) |  |  | χ2=2.787 | 0.095 |
| No | 3454 (93.77) | 1170 (95.41) |  |  |
| Yes | 230 (6.23) | 66 (4.59) |  |  |
| Energy, kcal/day, Mean (S.E) | 1704.60 (16.17) | 1674.53 (23.85) | t=1.05 | 0.296 |
| Protein, g/day, Mean (S.E) | 67.09 (0.59) | 62.99 (0.92) | t=4.02 | <0.001 |
| Carbohydrate, g/day, Mean (S.E) | 206.85 (1.79) | 199.48 (3.04) | t=2.03 | 0.046 |
| Fat, g/day, Mean (S.E) | 66.50 (0.62) | 65.66 (1.26) | t=0.61 | 0.541 |
| DAQS, score, Mean (S.E) | 4.19 (0.03) | 3.78 (0.08) | t=5.34 | <0.001 |
| DAQS, n (%) |  |  | χ2=32.814 | <0.001 |
| Low quality | 1531 (46.88) | 407 (36.53) |  |  |
| Medium quality | 559 (11.81) | 286 (20.93) |  |  |
| High quality | 1594 (41.30) | 543 (42.54) |  |  |
| Total femur BMD, gm/cm2, Mean (S.E) | 0.86 (0.00) | 0.83 (0.00) | t=6.99 | <0.001 |
| Femoral neck BMD, gm/cm2, Mean (S.E) | 0.73 (0.00) | 0.71 (0.00) | t=4.20 | <0.001 |
| Osteoporosis, n (%) |  |  | χ2=26.285 | <0.001 |
| No | 3364 (91.85) | 1057 (86.02) |  |  |
| Yes | 320 (8.15) | 179 (13.98) |  |  |
| Vegetable intake, n (%) |  |  | χ2=7.441 | 0.024 |
| Low level | 2226 (62.90) | 784 (68.23) |  |  |
| High level | 369 (11.88) | 125 (12.45) |  |  |
| Unknown | 1089 (25.21) | 327 (19.32) |  |  |
| Grain intake, n (%) |  |  | χ2=2.044 | 0.360 |
| Low level | 54 (1.55) | 20 (2.09) |  |  |
| High level | 2007 (60.11) | 631 (57.09) |  |  |
| Unknown | 1623 (38.34) | 585 (40.82) |  |  |
| Food intake sources of calcium |  |  |  |  |
| Milk and milk products, M (Q₁, Q₃) | 143.50 (0.00, 828.75) | 61.00 (0.00, 656.00) | Z=36.569 | 0.002 |
| Meat, poultry, fish, and mixtures, M (Q₁, Q₃) | 16.00 (0.00, 96.00) | 12.00 (0.00, 86.00) | Z=37.010 | 0.037 |
| Eggs, M (Q₁, Q₃) | 0.00 (0.00, 0.00) | 0.00 (0.00, 0.00) | Z=37.416 | 0.106 |
| Legumes, nuts, and seeds, M (Q₁, Q₃) | 0.00 (0.00, 7.00) | 0.00 (0.00, 0.00) | Z=36.638 | <0.001 |
| Grain products, M (Q₁, Q₃) | 272.00 (8.00, 816.00) | 190.00 (0.00, 625.00) | Z=35.965 | <0.001 |
| Fruits, M (Q₁, Q₃) | 3.00 (0.00, 39.00) | 0.00 (0.00, 22.00) | Z=35.758 | <0.001 |
| Vegetables, M (Q₁, Q₃) | 24.00 (0.00, 150.00) | 12.50 (0.00, 140.00) | Z=36.830 | 0.012 |
| Fats, oils, and salad dressings, M (Q₁, Q₃) | 0.00 (0.00, 2.00) | 0.00 (0.00, 2.00) | Z=37.433 | 0.207 |
| Sugars, sweets, and beverages, M (Q₁, Q₃) | 236.00 (28.00, 624.00) | 226.50 (10.00, 582.75) | Z=37.197 | 0.104 |

Note: GED=general educational development; AA=associate of arts; PIR=poverty to income ratio; BMI=body mass index; MET= metabolic equivalent; Cd= cadmium; 25(OH)D=25-hydroxyvitamin D; DAQS=dietary antioxidant quality score; BMD= bone mineral density; SE=standard error.