**Table 1. Descriptive statistics of mineral concentrations, health measurements and socio-demographics at the county level of USA**

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics, *n*=3080 | Median (Interquartile range) | Mean (Standard deviation) | Number (%) |
| Mineral concentrations (mg/kg) |  |  |  |
| Aluminum (Al) | 42540.70 (29615.75, 53565.75) | 41455.12 (17424.75) | - |
| Arsenic (As) | 5.82 (3.64, 8.33) | 6.61 (5.45) | - |
| Calcium (Ca) | 11005.60 (4136.61, 23438.50) | 17167.71 (20641.96) | - |
| Copper (Cu) | 12.29 (7.95, 17.49) | 14.40 (13.59) | - |
| Iron (Fe) | 21970.0 (16105.20, 28094.95) | 23468.66 (12567.84) | - |
| Lead (Pb) | 19.73 (15.22, 25.68) | 25.10 (39.70) | - |
| Magnesium (Mg) | 4927.41 (2295.22, 8317.33) | 6035.13 (5308.93) | - |
| Manganese (Mn) | 586.49 (380.47, 823.57) | 659.35 (456.59) | - |
| Mercury (Hg) | 0.03 (0.02, 0.05) | 0.06 (0.18) | - |
| Phosphorus (P) | 461.33 (277.95, 662.34) | 584.29 (963.36) | - |
| Selenium (Se) | 0.27 (0.19, 0.41) | 0.34 (0.26) | - |
| Sodium (Na) | 6192.78 (2299.24, 8718.04) | 6318.26 (4680.04) | - |
| Titanium (Ti) | 2974.72 (2452.35, 4200.04) | 3626.31 (1939.85) | - |
| Zinc (Zn) | 54.94 (35.83, 73.59) | 59.64 (48.18) | - |
| Health measurements |  |  |  |
| Life expectancy, year |  |  |  |
| Life expectancy (2014) | 77.93 (76.10, 79.47) | 77.75 (2.37) | - |
| Increase in life expectancy between 1980 and 2014 | 5.31 (4.07, 6.55) | 5.34 (1.99) | - |
| Age-specific mortality risk, % |  |  |  |
| 0 – 5 years | 0.67 (0.55, 0.83) | 0.71 (0.21) | - |
| 5 – 25 years | 0.92 (0.75, 1.13) | 0.96 (0.29) | - |
| 25 – 45 years | 2.93 (2.43, 3.62) | 3.08 (0.90) | - |
| 45 – 65 years | 12.79 (10.96, 15.22) | 13.22 (3.06) | - |
| 65 – 85 years | 52.41 (48.25, 56.47) | 52.33 (5.98) | - |
| Cause-specific mortality rate, number of deaths/100 000 Population |  |  |  |
| Communicable, maternal, neonatal, and nutritional diseases |  |  |  |
| HIV/AIDS and tuberculosis | 0.9 (0.56, 1.73) | 1.55 (2.07) | - |
| Diarrhea, lower respiratory and other common infectious diseases | 32.19 (26.13, 39.35) | 33.42 (10.53) | - |
| Neglected tropical diseases and malaria | 0.05 (0.04, 0.10) | 0.07 (0.06) | - |
| Maternal disorders | 0.32 (0.26, 0.42) | 0.36 (0.15) | - |
| Neonatal disorders | 3.05 (2.49, 3.88) | 3.36 (1.28) | - |
| Nutritional deficiencies | 1.50 (1.11, 1.93) | 1.59 (0.69) | - |
| Other communicable, maternal, neonatal, and nutritional diseases | 1.21 (1.03, 1.43) | 1.25 (0.32) | - |
| Noncommunicable diseases |  |  |  |
| Neoplasms | 204.27 (185.20, 225.99) | 206.54 (31.72) | - |
| Cardiovascular diseases | 272.25 (235.82, 315.91) | 278.31 (58.83) | - |
| Chronic respiratory diseases | 62.43 (52.28, 73.42) | 63.92 (16.87) | - |
| Cirrhosis and other chronic liver diseases | 17.26 (13.85, 20.91) | 18.38 (7.81) | - |
| Digestive diseases | 16.07 (14.62, 17.63) | 16.16 (2.44) | - |
| Neurological disorders | 95.87 (80.89, 110.93) | 95.89 (21.75) | - |
| Mental and substance use disorders | 11.69 (8.59, 16.02) | 13.14 (6.78) | - |
| Diabetes, urogenital, blood and endocrine diseases | 61.05 (51.45, 72.31) | 63.29 (17.88) | - |
| Musculoskeletal disorders | 3.10 (2.70, 3.61) | 3.22 (0.75) | - |
| Other non-communicable diseases | 6.58 (5.71, 7.61) | 6.78 (1.49) | - |
| Injuries |  |  |  |
| Transport injuries | 22.2 (16.39, 28.59) | 23.05 (9.23) | - |
| Unintentional injuries | 23.79 (20.90, 26.56) | 23.95 (4.97) | - |
| Self-harm and interpersonal violence | 21.06 (17.18, 25.23) | 21.86 (6.74) | - |
| Forces of nature, war and legal intervention | 0.07 (0.04, 0.11) | 0.09 (0.13) | - |
| Socio-demographics |  |  |  |
| Population characteristics |  |  |  |
| Size, n | 25932 (11257, 68081) | 101310 (324395) | - |
| Gender, male % | 49.6 (48.94, 50.47) | 50.04 (2.22) | - |
| Ethnicity, white alone % | 92.2 (80.95, 96.09) | 85.53 (15.78) | - |
| Age, % |  |  |  |
| 0 – 9 years | 12.12 (10.94, 13.27) | 12.22 (2.09) | - |
| 10 – 19 years | 12.86 (11.9, 13.84) | 12.89 (1.67) | - |
| 20 – 29 years | 11.7 (10.38, 13.3) | 12.31 (3.31) | - |
| 30 – 39 years | 11.42 (10.5, 12.42) | 11.53 (1.64) | - |
| 40 – 49 years | 12.22 (11.23, 13.17) | 12.2 (1.46) | - |
| 50 – 59 years | 14.71 (13.75, 15.55) | 14.61 (1.65) | - |
| 60 – 69 years | 12.05 (10.8, 13.41) | 12.28 (2.45) | - |
| 70 – 79 years | 7.28 (6.18, 8.45) | 7.44 (1.99) | - |
| ≥ 80 years | 4.32 (3.52, 5.26) | 4.53 (1.5) | - |
| Socio-economics |  |  |  |
| Educational level (age ≥ 25), % |  |  |  |
| Less than a high school diploma | 12.1 (8.8, 17.2) | 13.42 (6.32) | - |
| A high school diploma only | 34.6 (29.9, 39.3) | 34.32 (7.18) | - |
| Completing some college or associate's degree | 30.6 (27.25, 34.2) | 30.72 (5.19) | - |
| A bachelor's degree or higher | 19.2 (15, 25.5) | 21.54 (9.41) | - |
| Median household income (annual), US dollar | 45158.5 (38792.5, 52386) | 46963.46 (12008.42) | - |
| Unemployment rate, % | 6.0 (4.60, 7.50) | 6.22 (2.22) | - |
| Poverty rate, % | 15.80 (12.1, 20.4) | 16.87 (6.43) | - |
| Healthcare service |  |  |  |
| Medical insured population (age < 65), % | 86.10 (82.5, 89.5) | 85.72 (5.04) | - |
| Physicians (per 1000 population), *n* | 0.76 (0.39, 1.47) | 1.21 (1.62) | - |
| Residential environment and location |  |  |  |
| Rural-Urban Continuum Code |  |  |  |
| 1 (Metro areas, 1 million population or more) | - | - | 428 (13.90) |
| 2 (Metro areas, 250 thousand to 1 million population) | - | - | 375 (12.18) |
| 3 (Metro areas, population fewer than 250 thousand) | - | - | 350 (11.36) |
| 4 (Urban population of 20 thousand or more, adjacent to a metro area) | - | - | 213 (6.92) |
| 5 (Urban population of 20 thousand or more, not adjacent to a metro area) | - | - | 88 (2.86) |
| 6 (Urban population of 2,500 to 19,999, adjacent to a metro area) | - | - | 587 (19.06) |
| 7 (Urban population of 2,500 to 19,999, not adjacent to a metro area) | - | - | 418 (13.57) |
| 8 (Completely rural or less than 2,500 urban population, adjacent to a metro area) | - | - | 217 (7.05) |
| 9 (Completely rural or less than 2,500 urban population, not adjacent to a metro area) | - | - | 404 (13.12) |
| Latitude | 38.34 (34.69, 41.74) | 38.3 (4.83) | - |
| Longitude | -89.96 (-97.79, -83.33) | -91.51 (11.41) | - |

**Table 2. Association between concentrations of minerals and life expectancy in 2014**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables in univariate regression analysis | Regression coefficient | *p* value | 99.5% Confidence intervals | *R2* (adjusted) | Variables in multiple regression analysis | Regression coefficient | *p* value | 99.5% Confidence intervals | *R2* (adjusted) |
| - | - | - | - | - | Model | - |  | - | 0.295 |
| Al (mg/kg) | 5.93E-05 | <0.0001 | (5.31E-05, 6.55E-05) | 0.190 | - | - | - | - | - |
| As (mg/kg) | 0.033 | <0.0001 | (0.012, 0.055) | 0.006 | As (mg/kg) | -0.028 | <0.0001 | (-0.049, -0.008) | - |
| Ca (mg/kg) | 3.05E-05 | <0.0001 | (2.49E-05, 3.61E-05) | 0.070 | Ca (mg/kg) | 1.85E-05 | <0.0001 | (1.35E-05, 2.36E-05) | - |
| Cu (mg/kg) | 0.044 | <0.0001 | (0.036, 0.053) | 0.065 | - | - | - | - | - |
| Fe (mg/kg) | 5.23E-05 | <0.0001 | (4.31E-05, 6.15E-05) | 0.077 | - | - | - | - | - |
| Hg (mg/kg) | 0.692 | 0.003 | (0.038, 1.347) | 0.003 | - | - | - | - | - |
| Mg (mg/kg) | 1.64E-04 | <0.0001 | (1.43E-04, 1.85E-04) | 0.135 | - | - | - | - | - |
| Mn (mg/kg) | 8.26E-04 | <0.0001 | (5.66E-04, 1.08E-03) | 0.025 | - | - | - | - | - |
| Na (mg/kg) | 2.51E-04 | <0.0001 | (2.28E-04, 2.73E-04) | 0.245 | Na (mg/kg) | 2.19E-04 | <0.0001 | (1.96E-04, 2.42E-04) | - |
| P (mg/kg) | 2.41E-04 | <0.0001 | (1.18E-04, 3.65E-04) | 0.009 | - | - | - | - | - |
| Pb (mg/kg) | 0.006 | <0.0001 | (0.003, 0.009) | 0.012 | - | - | - | - | - |
| Se (mg/kg) | 1.702 | <0.0001 | (1.244, 2.161) | 0.034 | Se (mg/kg) | 0.957 | <0.0001 | (0.532, 1.382) | - |
| Ti (mg/kg) | 9.72E-05 | <0.0001 | (3.56E-05, 1.59E-04) | 0.006 | - | - | - | - | - |
| Zn (mg/kg) | 0.012 | <0.0001 | (0.01, 0.015) | 0.060 | Zn (mg/kg) | 0.005 | <0.0001 | (0.003,0.007) | - |

**Table 3. Cluster classification: posterior probability of membership of clusters**

|  |  |  |  |
| --- | --- | --- | --- |
| Assigned cluster,  *n* =3080 (%) | Mean posterior probability for each cluster  (Standard deviation) | | |
| The ‘Common’ cluster | The ‘Infertile’ cluster | The ‘Plentiful’ cluster |
| The ‘Common’ cluster, *n* = 2056  (66.75%) | 0.974 (0.075) | 0.013 (0.058) | 0.014 (0.051) |
| The ‘Infertile’ cluster, *n* = 739  (23.99%) | 0.053 (0.113) | 0.947 (0.113) | 0.0 (0) |
| The ‘Plentiful’, *n* = 285  (9.25%) | 0.064 (0.123) | 0.0 (0) | 0.936 (0.123) |

**Table 4.** **Association of clusters with life expectancy (2014) and change in life expectancy (1980-2014) with confounding adjustment**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variables in multivariate regression analysis | Life expectancy, 2014  Model *R2*(adjusted), 0.711 | | | Change in life expectancy, 1980-2014  Model *R2*(adjusted), 0.420 | | |
|  | Regression coefficient | 99.5% Confidence intervals | *p* value | Regression coefficient | 99.5% Confidence intervals | *p* value |
| Pattern of minerals |  |  |  |  |  |  |
| The ‘Common’ cluster | 0 (referent) | - | - | 0 (referent) | - | - |
| The ‘Infertile’ cluster | -0.437 | (-0.626, -0.248) | <0.0001 | -0.282 | (-0.507, -0.056) | <0.0001 |
| The ‘plentiful’ cluster | -0.129 | (-0.361, 0.104) | 0.120 | 0.101 | (-0.177, 0.378) | 0.308 |
| Population size, n (per 10 000 population) | 0.006 | (0.003, 0.008) | <0.0001 | 0.005 | (0.003, 0.008) | <0.0001 |
| Gender, male % | 0.117 | (0.084, 0.149) | <0.0001 | 0.132 | (0.093, 0.170) | <0.0001 |
| Ethnicity, white alone % | 0.022 | (0.016, 0.028) | <0.0001 | -0.034 | (-0.041, -0.027) | <0.0001 |
| Education level, bachelor’s degree % | 0.111 | (0.099, 0.123) | <0.0001 | 0.078 | (0.064, 0.092) | <0.0001 |
| Median household income, n (per 10 000 dollars) | 0.177 | (0.049, 0.305) | <0.0001 | 0.261 | (0.108, 0.414) | <0.0001 |
| Unemployment rate, % | -0.003 | (-0.044, 0.038) | 0.823 | 0.189 | (0.140, 0.238) | <0.0001 |
| Poverty rate, % | -0.115 | (-0.138, -0.091) | <0.0001 | -0.099 | (-0.127, -0.070) | <0.0001 |
| Insured population, % | -0.041 | (-0.061, -0.022) | <0.0001 | -0.111 | (-0.134, -0.088) | <0.0001 |
| Physicians, n (per 1000 population) | -0.073 | (-0.125, -0.020) | <0.0001 | 0.018 | (-0.044, 0.080) | 0.418 |
| Rural-Urban Continuum Code |  |  |  |  |  |  |
| 1 | 0 (referent) | - | - | 0 (referent) | - | - |
| 2 | 0.449 | (0.174, 0.724) | <0.0001 | 0.018 | (-0.310, 0.346) | 0.877 |
| 3 | 0.682 | (0.389, 0.976) | <0.0001 | 0.221 | (-0.129, 0.571) | 0.076 |
| 4 | 0.612 | (0.277, 0.947) | <0.0001 | 0.049 | (-0.351, 0.449) | 0.732 |
| 5 | 0.303 | (-0.15, 0.755) | 0.060 | -0.372 | (-0.912, 0.168) | 0.053 |
| 6 | 0.612 | (0.329, 0.895) | <0.0001 | 0.061 | (-0.277, 0.398) | 0.614 |
| 7 | 0.497 | (0.191, 0.802) | <0.0001 | -0.123 | (-0.487, 0.242) | 0.345 |
| 8 | 0.795 | (0.446, 1.144) | <0.0001 | 0.318 | (-0.099, 0.735) | 0.032 |
| 9 | 0.787 | (0.468, 1.106) | <0.0001 | 0.315 | (-0.066, 0.696) | 0.020 |
| Latitude | 0.094 | (0.074, 0.115) | <0.0001 | 0.102 | (0.078, 0.126) | <0.0001 |
| Longitude | -0.007 | (-0.014, 0.0) | 0.004 | 0.026 | (0.018, 0.034) | <0.0001 |