**Supplemental Material**

**Ultraviolet radiation exposure and breast cancer risk in the Nurses' Health Study II**

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**Table S1**: Associations between cumulative average UV exposure and breast cancer risk in NHSII among premenopausal women (1989-2013).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Outcomea | Cases (*n*) | Person-years (*n*) | Basicb  HR (95% CI) | Parsimoniousc  HR (95% CI) | Fully adjustedd  HR (95% CI) |
| Invasive breast cancer |  |  |  |  |  |
| UV quintile 1 | 470 | 341,252 | Referent | Referent | Referent |
| UV quintile 2 | 484 | 342,722 | 1.04 (0.91, 1.18) | 1.03 (0.91, 1.17) | 1.04 (0.91, 1.18) |
| UV quintile 3 | 437 | 345,573 | 0.94 (0.83, 1.07) | 0.95 (0.83, 1.08) | 0.94 (0.82, 1.07) |
| UV quintile 4 | 419 | 339,814 | 0.95 (0.83, 1.08) | 0.96 (0.84, 1.09) | 0.94 (0.82, 1.07) |
| UV quintile 5 | 441 | 319,412 | 0.98 (0.86, 1.12) | 0.97 (0.84, 1.11) | 0.95 (0.82, 1.09) |
| *p* for trend |  |  | 0.48 | 0.37 | 0.22 |
| Continuous UV (per IQR increase)e | 2,251 | 1,688,774 | 0.98 (0.94, 1.03) | 0.98 (0.93, 1.03) | 0.97 (0.93, 1.02) |
| ER+ |  |  |  |  |  |
| UV quintile 1 | 298 | 341,410 | Referent | Referent | Referent |
| UV quintile 2 | 318 | 342,869 | 1.07 (0.91, 1.25) | 1.07 (0.91, 1.25) | 1.07 (0.91, 1.25) |
| UV quintile 3 | 274 | 345,720 | 0.93 (0.79, 1.10) | 0.94 (0.80, 1.11) | 0.93 (0.79, 1.09) |
| UV quintile 4 | 263 | 339,957 | 0.95 (0.80, 1.12) | 0.96 (0.81, 1.13) | 0.93 (0.79, 1.10) |
| UV quintile 5 | 283 | 319,560 | 0.99 (0.84, 1.17) | 0.96 (0.81, 1.15) | 0.93 (0.78, 1.11) |
| *p* for trend |  |  | 0.58 | 0.36 | 0.17 |
| Continuous UV (per IQR increase)e | 1,436 | 1,689,516 | 0.98 (0.92, 1.04) | 0.97 (0.91, 1.03) | 0.96 (0.90, 1.02) |
| ER- |  |  |  |  |  |
| UV quintile 1 | 78 | 341,619 | Referent | Referent | Referent |
| UV quintile 2 | 78 | 343,080 | 1.01 (0.74, 1.39) | 1.01 (0.74, 1.38) | 1.02 (0.74, 1.40) |
| UV quintile 3 | 79 | 345,890 | 1.03 (0.75, 1.40) | 1.02 (0.75, 1.40) | 1.02 (0.74, 1.39) |
| UV quintile 4 | 69 | 340,126 | 0.91 (0.65, 1.25) | 0.91 (0.66, 1.26) | 0.91 (0.65, 1.26) |
| UV quintile 5 | 72 | 319,726 | 0.97 (0.70, 1.34) | 0.98 (0.70, 1.37) | 0.99 (0.71, 1.40) |
| *p* for trend |  |  | 0.58 | 0.62 | 0.69 |
| Continuous UV (per IQR increase)e | 376 | 1,690,441 | 0.99 (0.89, 1.11) | 1.00 (0.89, 1.12) | 1.00 (0.89, 1.13) |

a UV quintile 1: <166.6 mW/m2; quintile 2: ≥166.6-173.7 mW/m2; quintile 3: ≥173.7-182.9 mW/m2; quintile 4: ≥182.9-209.9 mW/m2; quintile 5: ≥209.9 mW/m2.

b Adjusted for age, race.

c Additionally adjusted for Census tract median home value, Census tract median income, marital status, living arrangements, individual-level income.

d Additionally adjusted for family history of breast cancer, personal history of biopsy-confirmed BBD, age at menarche, parity, age at first birth, lactation, height, BMI at age 18, change in BMI since age 18, physical activity, adult alcohol consumption, total vitamin D intake, population density.

e An IQR increase in cumulative average UV is 30.0 mW/m2.

**Table S2**: Associations between cumulative average UV exposure and breast cancer risk in NHSII among postmenopausal women (1989-2013).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Outcomea | Cases (*n*) | Person-years (*n*) | Basicb  HR (95% CI) | Parsimoniousc  HR (95% CI) | Fully adjustedd  HR (95% CI) |
| Invasive breast cancer |  |  |  |  |  |
| UV quintile 1 | 316 | 153,712 | Referent | Referent | Referent |
| UV quintile 2 | 322 | 154,301 | 1.01 (0.87, 1.18) | 1.02 (0.87, 1.19) | 1.01 (0.87, 1.19) |
| UV quintile 3 | 302 | 153,566 | 0.96 (0.82, 1.12) | 0.96 (0.82, 1.13) | 0.94 (0.80, 1.10) |
| UV quintile 4 | 305 | 154,969 | 0.98 (0.84, 1.15) | 1.01 (0.86, 1.18) | 0.96 (0.82, 1.12) |
| UV quintile 5 | 387 | 175,701 | 1.08 (0.93, 1.25) | 1.11 (0.95, 1.30) | 1.03 (0.88, 1.21) |
| *p* for trend |  |  | 0.27 | 0.14 | 0.66 |
| Continuous UV (per IQR increase)e | 1,632 | 792,249 | 1.04 (0.98, 1.11) | 1.06 (0.99, 1.13) | 1.02 (0.96, 1.09) |
| ER+ |  |  |  |  |  |
| UV quintile 1 | 165 | 153,856 | Referent | Referent | Referent |
| UV quintile 2 | 180 | 154,449 | 1.10 (0.89, 1.36) | 1.09 (0.89, 1.35) | 1.09 (0.88, 1.35) |
| UV quintile 3 | 156 | 153,697 | 0.95 (0.76, 1.18) | 0.95 (0.77, 1.19) | 0.93 (0.74, 1.16) |
| UV quintile 4 | 164 | 155,124 | 1.03 (0.83, 1.27) | 1.04 (0.83, 1.29) | 0.98 (0.79, 1.22) |
| UV quintile 5 | 223 | 175,851 | 1.18 (0.96, 1.44) | 1.17 (0.94, 1.44) | 1.06 (0.86, 1.32) |
| *p* for trend |  |  | 0.11 | 0.18 | 0.73 |
| Continuous UV (per IQR increase)e | 888 | 792,977 | 1.07 (0.98, 1.16) | 1.06 (0.97, 1.16) | 1.02 (0.93, 1.11) |
| ER- |  |  |  |  |  |
| UV quintile 1 | 41 | 153,980 | Referent | Referent | Referent |
| UV quintile 2 | 40 | 154,583 | 0.97 (0.63, 1.51) | 1.02 (0.66, 1.59) | 1.00 (0.64, 1.55) |
| UV quintile 3 | 39 | 153,810 | 0.97 (0.62, 1.51) | 1.00 (0.64, 1.55) | 0.98 (0.63, 1.54) |
| UV quintile 4 | 37 | 155,230 | 0.92 (0.59, 1.45) | 0.99 (0.63, 1.56) | 0.95 (0.60, 1.50) |
| UV quintile 5 | 38 | 176,020 | 0.83 (0.53, 1.30) | 0.96 (0.60, 1.53) | 0.90 (0.56, 1.43) |
| *p* for trend |  |  | 0.34 | 0.75 | 0.55 |
| Continuous UV (per IQR increase)e | 195 | 793,623 | 0.92 (0.76, 1.12) | 0.98 (0.80, 1.21) | 0.96 (0.78, 1.18) |

a UV quintile 1: <169.0 mW/m2; quintile 2: ≥169.0-175.1 mW/m2; quintile 3: ≥175.1-185.2 mW/m2; quintile 4: ≥185.2-217.1 mW/m2; quintile 5: ≥217.1 mW/m2.

b Adjusted for age, race.

c Additionally adjusted for Census tract median home value, Census tract median income, marital status, living arrangements, individual-level income.

d Additionally adjusted for family history of breast cancer, personal history of biopsy-confirmed BBD, age at menarche, parity, age at first birth, lactation, hormone use (among postmenopausal women only), height, BMI at age 18, change in BMI since age 18, physical activity, adult alcohol consumption, total vitamin D intake, population density.

e An IQR increase in cumulative average UV is 35.1 mW/m2.

**Table S3**: Cumulative average UV exposure and breast cancer risk stratified by sun exposure, sensitivity, and protection measures in NHSII.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Continuous UV (per IQR increase)a | | | |
| Sun exposure, sensitivity, and protection measures | Cases | Person-years | Fully adjustedb  HR (95% CI) | *p* int. |
| Number of sunburns from ages 15-20 |  |  |  | 0.43 |
| 0 | 1,436 | 879,685 | 0.96 (0.90, 1.02) |  |
| 1 | 772 | 526,487 | 1.04 (0.96, 1.13) |  |
| 2 | 702 | 431,779 | 0.98 (0.91, 1.07) |  |
| ≥3 | 1,036 | 650,589 | 1.02 (0.96, 1.09) |  |
| Hair color |  |  |  | 0.24 |
| Black | 143 | 78,041 | 0.85 (0.72, 1.00) |  |
| Blonde | 546 | 343,275 | 1.05 (0.96, 1.15) |  |
| Brown | 2,730 | 1,654,775 | 0.99 (0.95, 1.04) |  |
| Red | 131 | 81,370 | 1.01 (0.84, 1.23) |  |
| Sunscreen use as teenager |  |  |  | 0.17 |
| Not in sun | 86 | 46,916 | 0.89 (0.71, 1.12) |  |
| <50% | 2,813 | 1,649,470 | 0.98 (0.94, 1.02) |  |
| ≥50% | 492 | 310,842 | 1.02 (0.92, 1.12) |  |
| Time in direct sun during summer months |  |  |  | 0.32 |
| ≤1 hour/week | 795 | 409,657 | 1.00 (0.93, 1.08) |  |
| 2-4 hours/week | 1,420 | 787,707 | 0.96 (0.90, 1.02) |  |
| ≥5 hours/week | 860 | 565,040 | 1.05 (0.97, 1.13) |  |
| Time in direct sun during winter months |  |  |  | 0.38 |
| ≤1 hour/week | 1,575 | 892,346 | 1.02 (0.96, 1.08) |  |
| 2-4 hours/week | 1,185 | 656,610 | 0.97 (0.91, 1.03) |  |
| ≥5 hours/week | 318 | 210,885 | 1.07 (0.96, 1.19) |  |
| Time in direct sun during high school/college |  |  |  | 0.55 |
| ≤1 hour/week | 230 | 125,768 | 0.91 (0.78, 1.06) |  |
| 2-4 hours/week | 1,008 | 565,439 | 1.03 (0.96, 1.10) |  |
| ≥5 hours/week | 1,816 | 1,060,097 | 0.99 (0.94, 1.05) |  |
| Time in direct sun from ages 25-35 |  |  |  | 0.92 |
| ≤1 hour/week | 290 | 151,595 | 0.96 (0.85, 1.09) |  |
| 2-4 hours/week | 1,238 | 714,806 | 0.99 (0.93, 1.06) |  |
| ≥5 hours/week | 1,512 | 881,949 | 1.01 (0.95, 1.07) |  |
| Tanning booth use during high school/college |  |  |  | 0.41 |
| None | 2,772 | 1,596,394 | 1.01 (0.97, 1.06) |  |
| 1-2 times/year | 133 | 73,346 | 0.96 (0.79, 1.16) |  |
| ≥3 times/year | 153 | 87,462 | 0.87 (0.72, 1.05) |  |
| Tanning booth use from ages 25-35 |  |  |  | 0.74 |
| None | 2,526 | 1,415,395 | 1.01 (0.97, 1.06) |  |
| 1-2 times/year | 230 | 137,451 | 0.97 (0.83, 1.13) |  |
| ≥3 times/year | 305 | 203,946 | 0.95 (0.83, 1.10) |  |
| Tanning booth use during adulthood |  |  |  | 0.97 |
| None | 2,673 | 1,490,326 | 1.00 (0.96, 1.04) |  |
| 1-2 times/year | 117 | 72,346 | 1.02 (0.80, 1.29) |  |
| ≥3 times/year | 270 | 194,594 | 0.99 (0.84, 1.17) |  |

a An IQR increase in cumulative average UV is 30.0 mW/m2.

b Adjusted for age, race, Census tract median home value, Census tract median income, marital status, living arrangements, individual-level income, family history of breast cancer, personal history of biopsy-confirmed BBD, age at menarche, parity, age at first birth, lactation, hormone use (among postmenopausal women only), height, BMI at age 18, change in BMI since age 18, physical activity, adult alcohol consumption, total vitamin D intake, population density.

**Table S4**: Cumulative average UV exposure and breast cancer risk stratified by residential mobility in NHSII.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Never moved | | | Ever moved | | |  |
| Outcomea | Cases | Person-years | Fully adjustedb  HR (95% CI) | Cases | Person-years | Fully adjustedb  HR (95% CI) | *p* int. |
| Invasive breast cancer |  |  |  |  |  |  | 0.24 |
| UV quintile 1 | 249 | 137,879 | Referent | 541 | 362,449 | Referent |  |
| UV quintile 2 | 201 | 121,039 | 0.92 (0.76, 1.11) | 620 | 379,498 | 1.11 (0.99, 1.24) |  |
| UV quintile 3 | 161 | 100,365 | 0.89 (0.73, 1.08) | 599 | 402,842 | 1.00 (0.89, 1.13) |  |
| UV quintile 4 | 147 | 96,784 | 0.91 (0.74, 1.12) | 608 | 403,253 | 1.02 (0.90, 1.14) |  |
| UV quintile 5 | 129 | 74,858 | 0.89 (0.70, 1.12) | 704 | 418,471 | 1.05 (0.94, 1.18) |  |
| *p* for trend |  |  | 0.25 |  |  | 0.89 |  |
| Continuous UV (per IQR increase)c | 887 | 530,926 | 0.95 (0.87, 1.04) | 3,072 | 1,966,512 | 1.01 (0.97, 1.05) |  |
| ER+ |  |  |  |  |  |  | 0.37 |
| UV quintile 1 | 142 | 137,983 | Referent | 318 | 362,659 | Referent |  |
| UV quintile 2 | 127 | 121,117 | 1.00 (0.79, 1.28) | 377 | 379,729 | 1.14 (0.98, 1.33) |  |
| UV quintile 3 | 90 | 100,431 | 0.87 (0.66, 1.13) | 355 | 403,062 | 1.01 (0.87, 1.17) |  |
| UV quintile 4 | 86 | 96,848 | 0.93 (0.71, 1.22) | 359 | 403,498 | 1.03 (0.88, 1.19) |  |
| UV quintile 5 | 79 | 74,904 | 0.91 (0.67, 1.23) | 435 | 418,722 | 1.07 (0.91, 1.24) |  |
| *p* for trend |  |  | 0.38 |  |  | 0.97 |  |
| Continuous UV (per IQR increase)c | 524 | 531,284 | 0.94 (0.84, 1.06) | 1,844 | 1,967,671 | 1.00 (0.95, 1.06) |  |
| ER- |  |  |  |  |  |  | 0.63 |
| UV quintile 1 | 34 | 138,079 | Referent | 86 | 362,893 | Referent |  |
| UV quintile 2 | 25 | 121,206 | 0.91 (0.54, 1.55) | 102 | 379,982 | 1.18 (0.89, 1.58) |  |
| UV quintile 3 | 27 | 100,492 | 1.09 (0.65, 1.82) | 88 | 403,297 | 0.93 (0.69, 1.26) |  |
| UV quintile 4 | 26 | 96,889 | 1.15 (0.68, 1.94) | 86 | 403,743 | 0.94 (0.69, 1.27) |  |
| UV quintile 5 | 18 | 74,966 | 1.02 (0.55, 1.90) | 93 | 419,006 | 0.98 (0.72, 1.33) |  |
| *p* for trend |  |  | 0.83 |  |  | 0.47 |  |
| Continuous UV (per IQR increase)c | 130 | 531,632 | 1.04 (0.83, 1.30) | 455 | 1,968,920 | 0.99 (0.89, 1.10) |  |

a UV quintile 1: <166.6 mW/m2; quintile 2: ≥166.6-173.7 mW/m2; quintile 3: ≥173.7-182.9 mW/m2; quintile 4: ≥182.9-209.9 mW/m2; quintile 5: ≥209.9 mW/m2.

b Adjusted for age, race, Census tract median home value, Census tract median income, marital status, living arrangements, individual-level income, family history of breast cancer, personal history of biopsy-confirmed BBD, age at menarche, parity, age at first birth, lactation, hormone use (among postmenopausal women only), height, BMI at age 18, change in BMI since age 18, physical activity, adult alcohol consumption, total vitamin D intake, population density.

c An IQR increase in cumulative average UV is 30.0 mW/m2.