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| **Supplemental Table 1. Distribution of risk factors under study by cohort** | | | | | | | | | | | |
|  |  | **Overall** | **CPS2** | **MCCS** | **NIH-AARP** | **NHS** | **NHS2** | **PLCO** | **SMC** | **SWLH** | **WHI-OS** |
| Number of live births1 | Mean (% Missing) | 2.7 (0.3) | 3.2 (2.0) | 2.8 (0.3) | 2.6 (0.0) | 3.1 (0.0) | 2.1 (0.0) | 3.2 (0.0) | 2.4 (0.0) | 2.3 (0.0) | 3.0 (0.0) |
| Age at first birth1 | Mean (% Missing) | 24.3 (1.9) | 23.9 (2.4) | 25.0 (0.0) | 23.1 (0.0) | 25.1 (0.0) | 25.5 (0.0) | 23.1 (0.0) | 24.0 (2.0) | 25.4 (0.0) | 24.4 (10.8) |
| Years between menarche and first birth1 | Mean (% Missing) | 11.7 (2.4) | 11.3 (3.5) | 11.9 (0.0) | 10.5 (0.0) | 12.5 (0.0) | 13.1 (0.0) | 10.4 (0.0) | 10.9 (6.9) | 12.5 (1.2) | 11.8 (10.9) |
| Age at menarche | Mean (% Missing) | 12.6 (0.6) | 12.6 (1.6) | 13.1 (0.0) | 12.5 (0.0) | 12.5 (0.0) | 12.4 (0.0) | 12.7 (0.0) | 13.2 (5.1) | 13.0 (1.2) | 12.6 (0.3) |
| Age at menopause2 | Mean (% Missing) | 47.7 (8.3) | 47.6 (2.2) | 47.4 (0.3) | 47.3 (6.5) | 47.2 (0.4) | 33.1 (6.2) | 49.4 (22.3) | 50.3 (2.4) | - | 47.5 (9.8) |
| Alcohol intake | Mean (% Missing) | 0.2 (3.9) | 0.4 (4.0) | 0.3 (0.0) | - | 0.2 (0.0) | 0.0 (0.0) | 0.4 (20.0) | 0.0 (8.5) | 0.0 (0.0) | 0.4 (0.4) |
| Body mass index (kg/m2) | Mean (% Missing) | 25.6 (3.4) | 25.6 (1.4) | 26.7 (0.0) | 27.1 (13.9) | 24.4 (0.6) | 24.0 (1.3) | 27.2 (1.3) | 25.0 (1.8) | 23.5 (3.8) | 27.2 (1.2) |
| Parous | [%, (% missing)] | 85.9 (0.1) | 92.5 (0.0) | 86.3 (0.0) | 84.2 (0.0) | 94.4 (0.0) | 69.8 (0.0) | 92.5 (0.0) | 90.5 (0.0) | 88.3 (0.0) | 86.9 (0.6) |
| Ever HRT Use | [%, (% missing)] | 37.9 (3.6) | 56.3 (1.0) | 25.0 (0.8) | 58.4 (6.8) | 17.0 (1.4) | 3.1 (0.7) | 66.8 (0.5) | 45.3 (1.7) | 3.5 (23.7) | 60.6 (0.0) |
| Ever OC use | [%, (% missing)] | 50.6 (0.4) | 38.3 (1.2) | 58.8 (0.2) | 40.9 (0.5) | 50.3 (0.0) | 83.5 (0.1) | 54.4 (0.1) | 57.0 (2.6) | 16.4 (0.2) | 40.7 (0.0) |
| Family history of breast cancer | [%, (% missing)] | 11.2 (14.4) | 13.7 (0.0) | - | 14.5 (27.3) | 6.4 (8.8) | 2.0 (0.0) | 13.7 (1.8) | 8.8 (16.7) | 16.6 (0.0) | 17.8 (54.7) |
| History of benign breast disease | [%, (% missing)] | 23.3 (2.1) | 32.8 (0.0) | - | 15.5 (8.2) | 24.1 (0.0) | 28.6 (0.0) | 27.0 (2.3) | 0.3 (0.0) | - | - |
| Cigarette smoking status (%) | | | | | | | | |  |  |  |
|  | Never | 54.0 | 56.3 | 69.2 | 50.0 | 44.9 | 65.3 | 56.4 | 53.9 | 40.7 | 51.4 |
|  | Former | 32.7 | 35.5 | 21.7 | 42.3 | 27.6 | 21.3 | 34.1 | 22.9 | 36.9 | 42.5 |
|  | Current | 13.3 | 8.1 | 9.0 | 7.7 | 27.5 | 13.4 | 9.5 | 23.2 | 22.4 | 6.2 |
| 1 Among parous women 2 Among menopausal women |  |  |  |  |  |  |  |  |  |  |  |

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| **Supplemental Table 2. Multivariate1-adjusted associations of known and suspected breast cancer risk factors with invasive breast cancer risk by data availability of status of the estrogen receptor, progesterone receptor, and HER-2/*neu* in a pooled analysis of nine prospective cohort studies** | | | | | | | | |
|  |  | **Including cases with ER, PR, and HER2 data (“Analytical Cohort”)** | | **Including cases without ER, PR, and HER2** | | **p-value for heterogeneity2** |
|  |  | **Cases** | **HR (95% CI)** | **Cases** | **HR (95% CI)** |
| **Parity** | | | | | | | |
|  | No | 1,532 | 1.00 | 1,197 | 1.00 |  | |
|  | Yes | 10,191 | 0.82 (0.77, 0.86) | 8,485 | 0.81 (0.76, 0.86) | 0.88 | |
| **Number of live births among parous women** | | | | | | | |
|  | 1 births | 1,196 | 1.00 | 1,061 | 1.00 |  | |
|  | 2 births | 3,549 | 1.02 (0.96, 1.10) | 2,951 | 0.97 (0.91, 1.05) |  | |
|  | 3 births | 2,882 | 1.01 (0.94, 1.08) | 2,474 | 0.98 (0.91, 1.06) |  | |
|  | 4+ births | 2,534 | 0.91 (0.84, 0.98) | 1,955 | 0.87 (0.80, 0.94) |  | |
|  | Continuous |  | 0.96 (0.94, 0.98) |  | 0.96 (0.93, 0.98) | 0.77 | |
| **Age at first birth among parous women** | | | | | | | |
|  | <20 | 678 | 1.00 | 622 | 1.00 |  | |
|  | 20-24 | 5,337 | 1.08 (1.00, 1.18) | 4,051 | 1.09 (1.00, 1.19) |  | |
|  | 25-29 | 2,645 | 1.26 (1.15, 1.37) | 2,581 | 1.25 (1.14, 1.37) |  | |
|  | 30+ | 1,276 | 1.45 (1.32, 1.60) | 1,094 | 1.46 (1.32, 1.61) |  | |
|  | Continuous |  | 1.03 (1.02, 1.03) |  | 1.03 (1.02, 1.03) | 0.85 | |
| **Age at menarche** | | | | | | | |
|  | <12 | 2,506 | 1.00 | 2,080 | 1.00 |  | |
|  | 12 | 3,598 | 0.99 (0.94, 1.04) | 2,451 | 0.95 (0.90, 1.01) |  | |
|  | 13 | 2,859 | 0.97 (0.92, 1.03) | 2,706 | 0.97 (0.91, 1.02) |  | |
|  | 14+ | 2,708 | 0.94 (0.89, 1.00) | 2,366 | 0.97 (0.91, 1.03) |  | |
|  | Continuous |  | 0.98 (0.96, 1.00) |  | 0.99 (0.97, 1.01) | 0.34 | |
| **Years between menarche and first birth among parous women** | | | | | | | |
|  | 0-7.9 | 1,688 | 1.00 | 1,509 | 1.00 |  | |
|  | 8-9.9 | 1,746 | 1.05 (0.98, 1.12) | 1,515 | 1.05 (0.98, 1.13) |  | |
|  | 10-11.9 | 2,095 | 1.09 (1.02, 1.17) | 1,763 | 1.13 (1.05, 1.21) |  | |
|  | 12-14.4 | 2,112 | 1.15 (1.08, 1.23) | 1,446 | 1.12 (1.04, 1.21) |  | |
|  | 14.5-79 | 2,246 | 1.39 (1.30, 1.48) | 2,045 | 1.37 (1.28, 1.47) |  | |
|  | Continuous |  | 1.03 (1.02, 1.03) |  | 1.03 (1.02, 1.03) | 0.78 | |
| **Age at menopause** | | | | | | | |
|  | <50 | 3,144 | 0.83 (0.79, 0.87) | 2,643 | 0.84 (0.79, 0.89) |  | |
|  | 50-54 | 3,104 | 1.00 | 2,725 | 1.00 |  | |
|  | 55+ | 884 | 1.10 (1.02, 1.18) | 727 | 1.15 (1.06, 1.25) |  | |
|  | Continuous |  | 1.02 (1.02, 1.03) |  | 1.03 (1.02, 1.03) | 0.96 | |
| **Ever use of menopausal hormones** | | | | | | | |
|  | Never | 6,329 | 1.00 | 5,348 | 1.00 |  | |
|  | Ever | 5,171 | 1.20 (1.15, 1.26) | 4,006 | 1.17 (1.12, 1.23) | 0.46 | |
| **Ever use of oral contraceptives** | | | | | | | |
|  | Never | 5,716 | 1.00 | 5,164 | 1.00 |  | |
|  | Ever | 5,993 | 1.01 (0.97, 1.06) | 4,456 | 1.02 (0.98, 1.07) | 0.73 | |
| **First-degree family history of breast cancer** | | | | | | | |
|  | No | 7,658 | 1.00 | 6,819 | 1.00 |  | |
|  | Yes | 1,790 | 1.41 (1.33, 1.49) | 1,549 | 1.46 (1.38, 1.55) | 0.34 | |
| **Personal history of benign breast disease** | | | | | | | |
|  | No | 5,167 | 1.00 | 5,116 | 1.00 |  | |
|  | Yes | 2,431 | 1.32 (1.26, 1.39) | 2,251 | 1.34 (1.27, 1.41) | 0.69 | |
| **Body mass index among women <55** | | | | | | | |
|  | 18.5-22.4 | 354 | 1.00 | 473 | 1.00 |  | |
|  | 22.5-24.9 | 717 | 1.02 (0.90, 1.16) | 797 | 0.98 (0.87, 1.09) |  | |
|  | 25-29.9 | 265 | 0.97 (0.83, 1.14) | 337 | 0.89 (0.78, 1.03) |  | |
|  | 30+ | 121 | 0.90 (0.73, 1.10) | 142 | 0.82 (0.68, 0.99) |  | |
|  | Per 5 kg/m2 |  | 0.96 (0.90, 1.01) |  | 0.94 (0.89, 0.99) | 0.88 | |
| **Body mass index among women ≥55** | | | | | | | |
|  | 18.5-22.4 | 2,470 | 1.00 | 1,890 | 1.00 |  | |
|  | 22.5-24.9 | 2,430 | 0.89 (0.84, 0.94) | 1,892 | 0.88 (0.83, 0.94) |  | |
|  | 25-29.9 | 3,224 | 1.06 (1.01, 1.12) | 2,501 | 1.11 (1.05, 1.18) |  | |
|  | 30+ | 1,982 | 1.18 (1.11, 1.25) | 1,444 | 1.26 (1.17, 1.35) |  | |
|  | Per 5 kg/m2 |  | 1.09 (1.07, 1.11) |  | 1.12 (1.09, 1.14) | 0.21 | |
| **Alcohol intake at baseline** | | | | | | | |
|  | Not current | 3,074 | 1.00 | 2,666 | 1.00 |  | |
|  | <1 drink/day | 6,207 | 1.07 (1.02, 1.12) | 4,681 | 1.03 (0.98, 1.08) |  | |
|  | 1-2 drinks/day | 1,105 | 1.26 (1.17, 1.35) | 714 | 1.17 (1.08, 1.27) |  | |
|  | 2+ drinks/day | 383 | 1.43 (1.28, 1.59) | 319 | 1.21 (1.08, 1.37) |  | |
|  | Continuous |  | 1.13 (1.09, 1.17) |  | 1.08 (1.04, 1.13) | 0.14 | |
| **Cigarette smoking status** | | | | | | | |
|  | Never | 6,068 | 1.00 | 4,993 | 1.00 |  | |
|  | Former | 4,174 | 1.07 (1.03, 1.12) | 3,277 | 1.05 (1.01, 1.10) |  | |
|  | Current | 1,499 | 1.04 (0.98, 1.10) | 1,416 | 1.09 (1.02, 1.15) | 0.43 | |
| 1 Multivariable-adjusted models were stratified on age at enrollment (continuous) and cohort study and adjusted for race, education, age at menopause (categorical), age at menarche (continuous), parity, age at first birth, family history of breast cancer, benign breast disease, ever oral contraceptive use, ever menopausal hormone use, BMI (per 2 kg/m2), alcohol (categorical), age at smoking initiation (continuous) as well as subtype interactions with age at menopause, parity, age at first birth, benign breast disease, and alcohol intake.  2p-value for the difference between the relative risks for the case groups using a joint Cox proportional hazards regression model. | | | | | | | | |

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| **Supplementary Table 3. Interaction between cohort and potential risk factors within a joint Cox proportional hazards subtype model stratified on age at enrollment (continuous) and cohort study and adjusted for race, education, age at menopause (categorical), age at menarche (continuous), parity, age at first birth, family history of breast cancer, benign breast disease, ever oral contraceptive use, ever menopausal hormone use, BMI (per 2 kg/m2), alcohol (categorical), age at smoking initiation (continuous) as well as subtype interactions with age at menopause, parity, age at first birth, benign breast disease, and alcohol intake.** | |
| **Variable** | **P-interaction** |
| Parity | 0.59 |
| Number of births | 0.007 |
| Age at first birth | 0.05 |
| Age at menarche | 0.66 |
| Years between menarche and first birth | 0.87 |
| Age at menopause | 0.29 |
| Ever HRT use | 0.02 |
| Ever oral contraceptive use | 0.90 |
| Family history of breast cancer | 0.93 |
| Personal history of benign breast disease | 0.52 |
| Alcohol consumption | 0.68 |
| Smoking status | 0.18 |

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| **Supplemental Table 4. P-values for tumor heterogeneity between triple negative and HER2-enriched breast cancers corresponding to multivariable-adjusted hazard ratios in Table 2** | |
| **Exposure** | **P-heterogeneity** |
| Parity | 0.23 |
| Number of live births (continuous) | 0.45 |
| Age at first birth (continuous) | 0.49 |
| Age at menarche (continuous) | 0.30 |
| Years between menarche and first birth among parous women (continuous) | 0.29 |
| Age at menopause (continuous) | 0.24 |
| Ever use of menopausal hormones | 0.74 |
| Ever use of oral contraceptives | 0.51 |
| First-degree family history of breast cancer | 0.40 |
| Personal history of benign breast disease | 0.85 |
| Alcohol consumption (continuous) | 0.69 |
| Cigarette smoking status | 0.46 |

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| **Supplemental Table 5. Multivariate1-adjusted associations of BMI with invasive breast cancer risk by status of the estrogen receptor, progesterone receptor, and HER-2/*neu* and age at baseline among never menopausal hormone users in a pooled analysis of nine prospective cohort studies** | | | | | | | | | |
| **Categories of Subtype and Age at Baseline** | **Body Mass Index** | | | | | | | | **Per 5 kg/m2** |
| **18.5-22.4 kg/m2** | | **22.5-24.9 kg/m2** | | **25.0-24.9 kg/m2** | | **30.0+ kg/m2** | |
| **Cases** | **HR (95% CI)** | **Cases** | **Ref** | **Cases** | **HR (95% CI)** | **Cases** | **HR (95% CI)** |
| **Luminal A-like** |  |  |  |  |  |  |  |  |  |
| Age <55 | 464 | 1.03 (0.87, 1.21) | 220 | 1.00 | 169 | 1.01 (0.83, 1.24) | 72 | 0.87 (0.67, 1.13) | 0.94 (0.87, 1.01) |
| Age 55+ | 960 | 0.89 (0.82, 0.98) | 863 | 1.00 | 1076 | 1.08 (0.98, 1.18) | 768 | 1.31 (1.19, 1.45) | 1.11 (1.08, 1.14) |
| p-value for age interaction | |  |  |  |  |  |  | 0.15 | 3.2x10-5 |
| **Luminal B-like** |  |  |  |  |  |  |  |  |  |
| Age <55 | 100 | 1.45 (0.98, 2.15) | 34 | 1.00 | 33 | 1.26 (0.78, 2.03) | 11 | 0.82 (0.42, 1.62) | 0.89 (0.74, 1.07) |
| Age 55+ | 147 | 0.91 (0.72, 1.16) | 129 | 1.00 | 142 | 0.95 (0.75, 1.21) | 120 | 1.34 (1.04, 1.73) | 1.12 (1.04, 1.20) |
| p-value for age interaction | |  |  |  |  |  |  | 0.047 | 0.022 |
| p-value for tumor heterogeneity | |  |  |  |  |  |  | 0.580 | 0.902 |
| **HER2-enriched** |  |  |  |  |  |  |  |  |  |
| Age <55 | 41 | 1.03 (0.60, 1.76) | 20 | 1.00 | 9 | 0.58 (0.26, 1.26) | 4 | 0.50 (0.17, 1.47) | 0.78 (0.60, 1.03) |
| Age 55+ | 68 | 0.97 (0.68, 1.38) | 59 | 1.00 | 62 | 0.84 (0.59, 1.20) | 36 | 0.76 (0.50, 1.14) | 0.92 (0.81, 1.05) |
| p-value for age interaction | |  |  |  |  |  |  | 0.845 | 0.271 |
| p-value for tumor heterogeneity | |  |  |  |  |  |  | 0.036 | 0.015 |
| **Triple negative** |  |  |  |  |  |  |  |  |  |
| Age <55 | 69 | 0.78 (0.54, 1.14) | 44 | 1.00 | 22 | 0.64 (0.38, 1.06) | 16 | 0.91 (0.51, 1.61) | 1.00 (0.86, 1.17) |
| Age 55+ | 123 | 0.82 (0.64, 1.06) | 124 | 1.00 | 153 | 1.00 (0.79, 1.27) | 92 | 0.94 (0.71, 1.24) | 1.03 (0.95, 1.12) |
| p-value for age interaction | |  |  |  |  |  |  | 0.828 | 0.759 |
| p-value for tumor heterogeneity | | |  |  |  |  |  | 0.121 | 0.154 |
|  |  |  |  |  |  |  |  |  |  |
| p-value for overall tumor heterogeneity | | |  |  |  |  |  | 0.828 | 0.077 |
| 1 Multivariable-adjusted models were stratified on age at enrollment (continuous) and cohort study and adjusted for race, education, age at menopause (categorical), age at menarche (continuous), parity (1=nulliparous, 0=parous), age at first birth (continuous variable centered on median value among parous with the nulliparous and missing coded as that median value), family history of breast cancer, benign breast disease, ever oral contraceptive use, ever menopausal hormone use, BMI (per 2 kg/m2), alcohol (categorical), age at smoking initiation (continuous) as well as subtype interactions with age at menopause, parity, age at first birth, benign breast disease, and alcohol intake. 2 p-value for heterogeneity of that subtype compared to luminal A | | | | | | | | | |