

Supplemental Online Content

Leung CY, Huang HL, Abe SK, et al. Association of marital status with total and cause-specific mortality in Asia. *JAMA Netw Open*. 2022;5(5):e2214181. doi:10.1001/jamanetworkopen.2022.14181

eAppendix. Supplemental Methods

eTable 1. Descriptions and Basic Characteristics of Participating Cohorts

eTable 2. Baseline Characteristics for 623,140 Participants According to Marital Status

eTable 3. Association of Marital Status With Risk of All-Cause Mortality in Asian Populations

eTable 4. All-Cause Mortality Associated With Marital Status by Birth Years and Countries in Asian Populations

This supplemental material has been provided by the authors to give readers additional information about their work.

eAppendix. Supplemental Methods

Assessment of exposure

Analyses for subcategories of unmarried status (single, separated, widowed, and divorced) were performed where data were available. For JPHC1 and JPHC2, living arrangement with spouse was used as a proxy for being married, all others were categorized as not married. There were three unmarried status (single, widowed, and divorced) assessed in JACC and SCS, whereas the unmarried status in CVDFACTS were single, separated, and widowed. In two studies (RERF and SCHS/SGC), separated and divorced were combined into one category in the questionnaire; therefore, they were excluded from the analysis for separated and divorced. Miyagi and Ohsaki studies were not included for the analysis of separated, widowed, and divorced, since these three categories were merged into one in the questionnaires.

Outcome ascertainment

The causes of death were classified using the International Classification of Diseases, 9th or 10th Revision (ICD–9 or ICD–10): cancer (ICD–9 codes 140–208, ICD–10 codes C00 to C97), circulatory system diseases (ICD–9 codes 390–459, ICD–10 codes I00 to I99), coronary heart disease (ICD–9 codes 410–414, ICD–10 codes I20 to I25), cerebrovascular disease (ICD–9 codes 430–438, ICD–10 codes I60 to I69), respiratory diseases (ICD–9 codes 460–519, ICD–10 codes J00–J99), and external causes (ICD–9 codes 800–999, ICD–10 codes S00–T98).

eTable 1. Descriptions and Basic Characteristics of Participating Cohorts

| Cohort | Sample / Representativeness | Study entry | Collection of covariates | Baseline age, mean (SD) | Men /Women, No. (%) | Baseline health condition, No. (%) | Ref |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------------------|-------------------------|-------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------|
| China, Mainland | | | | | | | |
| SCS | A population-based cohort. Data were collected from the general population in four communities in urban Shanghai. | 1986-1989 | Structured questionnaire | 55.9 (5.7) | 16,751 (100) / 0 (0) | Healthy: 12,363 (73.8), HTN / DM: 4,256 (25.4), Cancer / CVD / CHD: 132 (0.8) | JAMA. 1996;275(21):1646-50. |
| SMHS | A population-based cohort. Data were collected from the general population in eight communities in urban Shanghai. | 2001-2006 | Self-administered questionnaire survey | 55.7 (9.7) | 53,205 (100) / 0 (0) | Healthy: 34,358 (64.6), HTN / DM: 14,411 (27.1) Cancer / CVD / CHD: 4,436 (8.3) | Int J Epidemiol. 2015;44(3):810-8. |
| SWHS | A population-based cohort. Data were collected from the general population in seven communities in urban Shanghai. | 1996-2000 | Self-administered questionnaire survey | 52.6 (9.1) | 0 (0) / 74,743 (100) | Healthy: 52,566 (70.3), HTN / DM: 14,702 (19.7), Cancer / CVD / CHD: 7,475 (10) | Am J Epidemiol. 2005;162(11):1123-31. |
| Japan | | | | | | | |
| JACC | A population-based cohort including data collected from the general population in 45 areas. | 1988-1990 | Self-administered questionnaire survey | 57.1 (10.0) | 31,337 (41.8) / 43,652 (58.2) | Healthy: 55,436 (73.9), HTN / DM: 15,528 (20.7), Cancer / CVD / CHD: 4,025 (5.4) | J Epidemiol. 2013;23(3):227-32. |
| JPHC1 | A population-based cohort. Data were collected from five public health center areas across Japan. | 1990-1992 | Self-administered questionnaire survey | 49.6 (6.0) | 20,352 (47.8) / 22,235 (52.2) | Healthy: 33,585 (78.9), HTN / DM: 7,487 (17.6), Cancer / CVD / CHD: 1,515 (3.6) | J Epidemiol. 2001;11(6 Suppl):S3-7. |
| JPHC2 | A population-based cohort. Data were collected from six public health center areas across Japan. | 1992-1995 | Self-administered questionnaire survey | 54.2 (8.8) | 26,407 (47.3) / 29,434 (52.7) | Healthy: 40,707 (72.9), HTN / DM: 12,878 (23.1), Cancer / CVD / CHD: 2,256 (4.04) | J Epidemiol. 2001;11(6 Suppl):S3-7. |
| Miyagi | A population-based cohort including data collected from 14 municipalities of Miyagi Prefecture. | 1990 | Self-administered questionnaire survey | 51.9 (7.5) | 18,919 (50.8) / 19,002 (50.1) | Healthy: 28,892 (76.2), HTN / DM: 7,859 (20.7), Cancer / CVD / CHD: 1,170 (3.1) | J Epidemiol. 2004;14 Suppl 1(Suppl I):S2-6. |
| Ohsaki | A cohort study on all National Health Insurance beneficiaries, aged 40-79 years, who lived in the catchment area of the Ohsaki Public Health Center, Miyagi, Japan | 1995 | Self-administered questionnaire survey | 58.0 (10.8) | 14,609 (54.2) / 12,341 (45.8) | Healthy: 18,120 (67.2), HTN / DM: 6,754 (25.1), Cancer / CVD / CHD: 2,076 (7.7) | J Epidemiol. 1998;8(5):258-63. |
| RERF | A cohort including 120,000 atomic bomb survivors and matched residents who were | 1963-1993 | Self-administered questionnaire survey | 52.1 (13.6) | 18,691 (39.6) / 28,509 (60.4) | Healthy: 34,740 (73.6), HTN / DM: 12,460 (26.4) | Radiat Res. 1962;16:253-80. |

| | | | | | | | |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------|-------------|-------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------|
| | not in Hiroshima or Nagasaki at the time of bombing. | | | | | | |
| Takayama | A population-based cohort including data collected from Takayama residents aged 35 years or above. | 1992 | Self-administered questionnaire survey | 55.8 (12.8) | 13,961 (45.7) / 16,613 (54.3) | Healthy: 22,345 (73.1), HTN / DM: 5,917 (19.4), Cancer / CVD / CHD: 2,312 (7.6) | Jpn J Clin Oncol. 1999;29(1):38-44. |
| Korea, Republic of | | | | | | | |
| KMCC | A population-based cohort including participants who were voluntary participants in a cancer screening survey in 19 sites in South Korea. | 1993-2004 | Trained interviewers administered questionnaires | 53.9 (14.5) | 7,718 (39.9) / 11,619 (60.1) | Healthy: 15,794 (81.7), HTN / DM: 2,542 (13.2), Cancer / CVD / CHD: 1,001 (5.2) | Asian Pacific J Cancer Prev, 3, 85-92. |
| KNCC | A cohort including participants who were enrolled for health check-ups at the Center for Cancer Prevention and Detection at the National Cancer Center in South Korea | 2001-2015 | Trained interviewers administered questionnaires | 49.8 (9.2) | 19,113 (50.8) / 18,525 (49.2) | Healthy: 28,611 (76.0), HTN / DM: 6,781 (18.0), Cancer / CVD / CHD: 2,246 (6.0) | Epidemiol Health. 2014; 36: e2014013. |
| Seoul-Male | A cohort including men living in or near Seoul, who were beneficiaries of the Korea Medical Insurance Corporation. | 1992-1993 | Self-administered questionnaire survey | 49.2 (5.2) | 13,957 (100) / 0 (0) | Healthy: 12,400 (88.8), HTN / DM: 1,471 (10.5), Cancer / CVD / CHD: 86 (0.6) | Journal of Preventive Medicine and Public Health 2012; 45(1): 14-20. |
| Singapore | | | | | | | |
| SCHS (SGC) | A population-based cohort. Data were collected from permanent residents or citizens of Singapore who resided in government-built housing estates. | 1993-1999 | Self-administered questionnaire survey | 56.4 (8.0) | 27,593 (44.0) / 35,065 (56.0) | Healthy: 42,557 (67.9), HTN / DM: 15,118 (24.1), Cancer / CVD / CHD: 4,983 (8.0) | Nutr Cancer. 2001;39(2):187-95. |
| Taiwan | | | | | | | |
| CBCSP | A cohort including residents in seven townships in Taiwan. | 1991-1992 | Trained public health nurses administered questionnaires | 47.3 (10.0) | 11,883 (50.2) / 11,787 (49.8) | Healthy: 21,391 (90.4), HTN / DM: 1,644 (7.0), Cancer / CVD / CHD: 635 (2.7) | N Engl J Med. 2002;347(3):168-74. |
| CVDFACTS | A cohort randomly selecting residents of ten villages in two townships in Taiwan (Chu-Dung and Pu-Tze). | 1990-1993 | Trained interviewers administered questionnaires | 47.5 (15.6) | 2,247 (43.9) / 2,872 (56.1) | Healthy: 4,267 (83.4), HTN / DM: 672 (13.1), Cancer / CVD / CHD: 180 (3.5) | Stroke. 2009;40(5):1578-84. |

Abbreviations: No., number; CVD, cerebrovascular disease; CHD, coronary heart disease; DM, diabetes mellitus; HTN, hypertension; SCS, Shanghai Cohort Study; SMHS, Shanghai Men's Health Study; SWHS, Shanghai Women's Health Study; JACC, Japan Collaborative Cohort Study; JPHC, Japan Public Health Center-based prospective Study; Miyagi, Miyagi Cohort Study; Ohsaki, Ohsaki National Health Insurance Cohort Study; RERF, Life Span Study Cohort-Radiation Effects Research Foundation; Takayama, Takayama Study; KMCC, Korean Multi-center Cancer Cohort Study; KNCC, Korea National Cancer Center Cohort; Seoul-Male, Seoul Male Cancer Cohort; SCHS, Singapore Chinese Health Study; CBCSP, Community-based Cancer Screening Project; CVDFACTS, Cardiovascular Diseases Risk Factor two-Township Study.

eTable 2. Baseline Characteristics for 623,140 Participants According to Marital Status

| Characteristic | Married | Single | Separated | Divorced | Widowed |
|-----------------------------------------|----------------|---------------|------------------|-----------------|----------------|
| Participants, No. (%) | 538,377 (86.4) | 14,454 (2.3) | 1,347 (0.2) | 35,212 (5.7) | 5,674 (0.9) |
| Men, No. (%) | 268,975 (50.0) | 7,452 (51.6) | 228 (16.9) | 6,437 (18.3) | 1,792 (31.6) |
| Women, No. (%) | 269,402 (50.0) | 7,002 (48.4) | 1,119 (83.1) | 28,775 (81.7) | 3,882 (68.4) |
| Age, mean (SD), y | 53.3 (9.7) | 46.7 (13.8) | 52.4 (9.9) | 62.2 (11.1) | 51.6 (9.7) |
| Smoking status | | | | | |
| Never, No. (%) | 311,216 (57.8) | 7,973 (55.2) | 1,043 (77.4) | 25,184 (71.5) | 3,238 (57.1) |
| Former, No. (%) | 57,654 (10.7) | 1,038 (7.2) | 79 (5.9) | 2,037 (5.8) | 448 (7.9) |
| Current, No. (%) | 153,776 (28.6) | 4,960 (34.3) | 217 (16.1) | 6,407 (18.2) | 1,760 (31.0) |
| Missing, No. (%) | 15,731 (2.9) | 483 (3.3) | 8 (0.6) | 1,584 (4.5) | 228 (4.0) |
| Alcohol intake | | | | | |
| Non-drinker, No. (%) | 327,087 (60.8) | 8,629 (59.7) | 1,042 (77.4) | 26,033 (73.9) | 3,207 (56.5) |
| Drinker, No. (%) | 200,711 (37.3) | 5,516 (38.2) | 299 (22.2) | 8,614 (24.5) | 2,355 (41.5) |
| Missing, No. (%) | 10,579 (2.0) | 309 (2.1) | 6 (0.5) | 565 (1.6) | 112 (2.0) |
| Physical activity | | | | | |
| None or almost none, No. (%) | 181,437 (33.7) | 2,448 (16.9) | 580 (43.1) | 7,937 (22.5) | 2,175 (38.3) |
| Low, No. (%) | 62,481 (11.6) | 1,880 (13.0) | 199 (14.8) | 3,628 (10.3) | 1,002 (17.7) |
| Intermediate, No. (%) | 139,066 (25.8) | 4,969 (34.4) | 200 (14.9) | 9,973 (28.3) | 792 (14.0) |
| High, No. (%) | 36,654 (6.8) | 484 (3.35) | 168 (12.5) | 3,147 (8.9) | 358 (6.3) |
| Missing, No. (%) | 118,739 (22.1) | 4,673 (32.3) | 200 (14.9) | 10,527 (29.9) | 1,347 (23.7) |
| Education | | | | | |
| No formal or primary education, No. (%) | 193,501 (39.6) | 5,649 (39.3) | 337 (28.0) | 23,495 (66.7) | 1,780 (31.4) |
| Secondary education, No. (%) | 158,878 (32.5) | 4,990 (34.7) | 509 (37.8) | 6,690 (19.0) | 2,123 (37.4) |
| Trade or technical education, No. (%) | 56,633 (11.6) | 1,171 (8.1) | 247 (18.3) | 1,412 (4.0) | 775 (13.7) |
| University education or above, No. (%) | 62,522 (12.8) | 2,088 (14.5) | 198 (14.7) | 1,589 (4.5) | 740 (13.1) |
| Missing, No. (%) | 17,211 (3.5) | 483 (3.4) | 16 (1.2) | 2,022 (5.7) | 252 (4.4) |

Abbreviations: No., number; CI, confidence intervals.

eTable 3. Association of Marital Status With Risk of All-Cause Mortality in Asian Populations

| | HR (95% CI) ^a | | | | | |
|---------------------------------------------|--------------------------|---------------------------|----------------------|------------------------|-----------------------|-----------------------|
| | Married (n=538,377) | Not married (n=84,763) | Single (n=13,159) | Separated (n=1,168) | Divorced (n=4,671) | Widowed (n=33,997) |
| Multivariable model | | | | | | |
| Death no. | 100,249 | 23,015 | 3,072 | 164 | 641 | 11,651 |
| All-cause mortality | 1 [ref] | 1.15 (1.07-1.24) | 1.62 (1.41-1.86) | 1.35 (1.13-1.61) | 1.38 (1.13-1.69) | 1.09 (1.04-1.13) |
| Excluding first 5 years of follow-up | | | | | | |
| Death no. | 85,101 | 19,129 | 2,536 | 136 | 502 | 9,466 |
| All-cause mortality | 1 [ref] | 1.14 (1.05-1.22) | 1.59 (1.38-1.83) | 1.42 (1.18-1.71) | 1.28 (1.07-1.54) | 1.08 (1.04-1.13) |

Abbreviations: HR, hazard ratio; CI, confidence intervals; no., number.

^a Multivariable Cox regression model adjusted for sex, age at baseline (year, continuous), smoking status (never, former, current, and missing), education (no formal education or primary education, secondary education, trade or technical education, university education or above, and missing), physical activity (none or almost none, low, intermediate, high, and missing), alcohol intake (non-drinker, drinker, and missing), and baseline health conditions (stroke, coronary heart disease, cancer, hypertension, and diabetes mellitus).

eTable 4. All-Cause Mortality Associated With Marital Status by Birth Years and Countries in Asian Populations

| Characteristic | Married | Not married | Single | Separated | Divorced | Widowed |
|--------------------------------|------------|------------------|------------------|------------------|------------------|------------------|
| | HR (95%CI) | HR (95%CI) | HR (95%CI) | HR (95%CI) | HR (95%CI) | HR (95%CI) |
| Birth year ^a | | | | | | |
| Death no. | 84,626 | 20,562 | 744 | 53 | 168 | 419 |
| Before 1940 | 1 [ref] | 1.10 (1.04-1.17) | 1.44 (1.24-1.68) | 1.22 (1.01-1.48) | 1.23 (1.01-1.51) | 1.08 (1.04-1.12) |
| Death no. | 15,623 | 2,453 | 764 | 75 | 192 | 7,416 |
| In or after 1940 | 1 [ref] | 1.46 (1.26-1.69) | 1.96 (1.66-2.32) | 2.03 (1.32-3.12) | 1.60 (1.22-2.10) | 1.18 (1.04-1.35) |
| Country ^a | | | | | | |
| Death no. | 19,816 | 2,381 | 258 | 70 | 265 | 1,788 |
| Mainland China | 1 [ref] | 1.32 (1.10-1.60) | 2.14 (1.80-2.54) | 1.14 (0.90-1.44) | 1.39 (0.99-1.96) | 1.11 (1.06-1.17) |
| Death no. | 63,269 | 16,032 | 2,073 | 37 | 320 | 6,349 |
| Japan | 1 [ref] | 1.08 (1.00-1.17) | 1.44 (1.20-1.73) | 1.51 (1.09-2.09) | 1.18 (0.96-1.46) | 1.06 (0.99-1.13) |
| Death no. | 3,994 | 1,037 | 46 | 37 | 38 | 916 |
| Korea | 1 [ref] | 1.18 (1.09-1.28) | 1.67 (1.12-2.50) | 1.31 (0.95-1.81) | 1.98 (1.33-2.96) | 0.87 (0.55-1.38) |
| Death no. | 10,258 | 2,980 | 497 | -- | -- | 2,249 |
| Singapore | 1 [ref] | 1.16 (1.11-1.21) | 1.39 (1.27-1.52) | -- | -- | 1.11 (1.06-1.17) |
| Death no. | 2,912 | 585 | 198 | 20 | 18 | 349 |
| Taiwan | 1 [ref] | 1.18 (0.75-1.87) | 1.44 (1.20-1.73) | 1.76 (1.13-2.75) | 1.06 (0.67-1.70) | 1.03 (0.74-1.44) |

Abbreviations: HR, hazard ratio; CI, confidence intervals; no., number.

^a Multivariable Cox regression model adjusted for gender, age at baseline (year, continuous), smoking status (never, former, current, and missing), education (no formal education or primary education, secondary education, trade or technical education, university education or above, and missing), physical activity (none or almost none, low, intermediate, high, and missing), alcohol intake (non-drinker, drinker, and missing), and baseline health conditions (stroke, coronary heart disease, cancer, hypertension, and diabetes mellitus).