**Supplemental Table 1**. Characteristics of participants with baseline and additional surveys and accelerometer study in the Kyoto–Kameoka Study

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Only first survey | | | |  | First and second survey | |  | Accelerometer study | |
| All participants (*n* = 13294) | | Participants without LTC (*n* = 12054) | |  | All participants (*n* = 8319) | |  | Included participants (*n* = 4165) | |
| Age [years] \* | 74.5 | (6.9) | 73.7 | (6.3) |  | 73.6 | (6.2) |  | 72.3 | (5.4) |
| Women [*n* (%)] † | 7337 | (55.2) | 6456 | (53.6) |  | 4412 | (53.0) |  | 2028 | (48.7) |
| PD ≥1000 people/km2 [*n* (%)] † | 5917 | (44.5) | 5377 | (44.6) |  | 3814 | (45.8) |  | 2037 | (48.9) |
| Body mass index [kg/m2] \* | 22.5 | (3.6) | 22.6 | (3.5) |  | 22.6 | (3.5) |  | 22.7 | (3.2) |
| Living alone [*n* (%)] † | 1695 | (12.8) | 1427 | (11.8) |  | 966 | (11.6) |  | 481 | (11.5) |
| HSES [*n* (%)] † | 4228 | (31.8) | 3832 | (31.8) |  | 2770 | (33.3) |  | 1469 | (35.3) |
| Education ≥13 years [*n* (%)] † | 2567 | (19.3) | 2387 | (19.8) |  | 1745 | (21.0) |  | 989 | (23.7) |
| Current smoker [*n* (%)] † | 1397 | (10.5) | 1346 | (11.2) |  | 867 | (10.4) |  | 422 | (10.1) |
| Alcohol drinker [*n* (%)] † | 8277 | (62.3) | 7776 | (64.5) |  | 5470 | (65.8) |  | 2892 | (69.4) |
| Denture use [*n* (%)] † | 8418 | (63.3) | 7464 | (61.9) |  | 5127 | (61.6) |  | 2432 | (58.4) |
| No medication [*n* (%)] † | 2604 | (19.6) | 2516 | (20.9) |  | 1826 | (21.9) |  | 1020 | (24.5) |
| No. of chronic diseases \*,‡ | 0.96 | (1.00) | 0.93 | (0.97) |  | 0.95 | (0.97) |  | 0.93 | (0.95) |
| Frailty [*n* (%)] † | 5321 | (44.4) | 4229 | (39.2) |  | 2768 | (36.9) |  | 1029 | (24.7) |
| Mortality [event/1000 PY] § | 27.2 | | 21.4 | |  | 17.1 | |  | 8.0 | |
| [95% CI] § | (26.0 to 28.5) | | (20.3 to 22.6) | |  | (15.9 to 18.4) | |  | (6.7 to 9.7) | |

LTC, long-term care; PD, population density; HSES, high socioeconomic status; PY, person-years; CI, confidence interval

Missing values were supplemented using the multivariate imputation method in all participants (*n* = 13294): body mass index (*n* = 1039; 7.8%), family structure (*n* = 1119; 8.4%), socioeconomic status (*n* = 730; 5.5%), education attainment (*n* = 1895; 14.3%), smoking status (*n* = 702; 5.3%), alcohol drinker (*n* = 604; 4.5%), denture use (*n* = 405; 3.0%), medications (*n* = 1140; 8.6%), and frailty status (*n* = 1722; 13.0%). Body mass index was calculated as body weight (kg) divided by height squared (m2).

\* Continuous values are shown as mean (standard deviation).

† Categorical values are shown as number (percentage).

‡ From the data obtained on disease status (including the presence of hypertension, stroke, heart disease, diabetes, hyperlipidemia, digestive disease, respiratory disease, urological diseases, and cancer), the comorbidity scores were summed to obtain a total score ranging from 0 (no comorbidity) to 9 (poor status).

§ Mortality was calculated using data from July 30, 2011, to November 30, 2016. Mortality risk is shown as rate (95% CI) per 1000 person-years.

**Supplemental Table 2.** Results of sensitivity analysis for the relationship between all-cause mortality and daily step count using complete case data

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Step counts | *n* | Event | PY | Event/1000 PY | | Model 1 \* | | Model 2 † | |
| Rate | 95% CI | HR | 95% CI | HR | 95% CI |
| **Total** |  | | | | | | | | |
| Q1 (1789 steps) | 712 | 39 | 2347 | 16.6 | (12.1 to 22.7) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3026 steps) | 727 | 16 | 2456 | 6.5 | (4.0 to 10.6) | 0.66 | (0.36 to 1.20) | 0.67 | (0.36 to 1.22) |
| Q3 (4466 steps) | 745 | 10 | 2532 | 3.9 | (2.1 to 7.3) | 0.52 | (0.25 to 1.07) | 0.52 | (0.25 to 1.09) |
| Q4 (7530 steps) | 739 | 3 | 2536 | 1.2 | (0.4 to 3.7) | 0.19 | (0.06 to 0.63) | 0.21 | (0.06 to 0.70) |
| *p for trend* ‡ |  |  |  |  |  | 0.001 | | 0.002 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 2,923 |  |  |  |  | 0.70 | (0.52 to 0.88) | 0.71 | (0.52 to 0.89) |
| < 5000 steps | 2,049 |  |  |  |  | 0.63 | (0.36 to 0.91) | 0.65 | (0.37 to 0.93) |
| ≥ 5000 steps | 874 |  |  |  |  | 1.02 | (0.50 to 1.54) | 0.72 | (0.12 to 1.32) |
| **Frailty** § |  | | | | | | | | |
| Q1 (1590 steps) | 193 | 14 | 633 | 22.1 | (13.1 to 37.3) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (2480 steps) | 183 | 11 | 608 | 18.1 | (10.0 to 32.6) | 1.15 | (0.51 to 2.58) | 1.06 | (0.46 to 2.44) |
| Q3 (3722 steps) | 192 | 4 | 654 | 6.1 | (2.3 to 16.3) | 0.51 | (0.16 to 1.63) | 0.46 | (0.14 to 1.48) |
| Q4 (6449 steps) | 184 | 1 | 631 | 1.6 | (0.2 to 11.3) | 0.16 | (0.02 to 1.29) | 0.13 | (0.02 to 1.06) |
| *p for trend* ‡ |  |  |  |  |  | 0.032 | | 0.018 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 752 |  |  |  |  | 0.65 | (0.33 to 0.97) | 0.61 | (0.29 to 0.93) |
| < 2500 steps | 290 |  |  |  |  | 1.03 | (0.03 to 2.03) | 0.99 | (0.03 to 2.01) |
| ≥ 2500 steps | 462 |  |  |  |  | 0.34 | (0.06 to 1.10) | 0.38 | (0.07 to 1.15) |
| **Non-frailty** § |  | | | | | | | | |
| Q1 (1938 steps) | 514 | 22 | 1702 | 12.9 | (8.5 to 19.6) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3218 steps) | 538 | 8 | 1820 | 4.4 | (2.2 to 8.8) | 0.54 | (0.23 to 1.24) | 0.65 | (0.28 to 1.53) |
| Q3 (4689 steps) | 559 | 5 | 1903 | 2.6 | (1.1 to 6.3) | 0.37 | (0.14 to 1.00) | 0.43 | (0.16 to 1.21) |
| Q4 (7804 steps) | 560 | 3 | 1920 | 1.6 | (0.5 to 4.8) | 0.30 | (0.09 to 1.08) | 0.38 | (0.11 to 1.38) |
| *p for trend* ‡ |  |  |  |  |  | 0.012 | | 0.035 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 2,171 |  |  |  |  | 0.71 | (0.48 to 0.93) | 0.75 | (0.72 to 0.98) |
| < 5000 steps | 1,442 |  |  |  |  | 0.43 | (0.03 to 0.84) | 0.50 | (0.09 to 0.91) |
| ≥ 5000 steps | 729 |  |  |  |  | 1.06 | (0.55 to 1.58) | 0.72 | (0.12 to 1.32) |

PY, person-years; CI, confidence interval; HR, hazard ratio; Q, quartiles; Ref, reference. Q1 through Q4 include daily step counts of <2436, 2437–3650, 3654–5378, and ≥5379 steps, respectively in total participants; <2027, 2030–3013, 3028–4473, and ≥4474 steps, respectively, in frail individuals; and <2620, 2624–3891, 3894–5617, and ≥5642 steps, respectively, in non-frail individuals. The step counts are expressed these quartiles (mean values).

\* Model 1: Adjusted for age, sex, population density, and season of wear.

† Model 2: Adjusted for Model 1 and body mass index, smoking status, alcohol consumption status, family structure, educational attainment, economic status, denture use, medication use, number of chronic diseases, and frailty status.

‡ Linear trend *p*-values were calculated using the likelihood ratio test and a continuous variable of daily step counts.

§ Variables (frailty) used for subgroup analysis were excluded from the adjustment for covariate variables in the model.

**Supplemental Table 3.** Results of sensitivity analysis for the relationship between all-cause mortality and daily step count after excluding participants with an event in the first one year of follow-up

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Step counts | *n* | Event | PY | Event/1000 PY | | Model 1 \* | | Model 2 † | |
| Rate | 95% CI | HR | 95% CI | HR | 95% CI |
| **Total** |  | | | | | | | | |
| Q1 (1787 steps) | 1034 | 52 | 3443 | 15.1 | (11.5 to 19.8) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3029 steps) | 1038 | 28 | 3501 | 8.0 | (5.5 to 11.6) | 0.89 | (0.56 to 1.43) | 0.88 | (0.55 to 1.42) |
| Q3 (4452 steps) | 1040 | 13 | 3543 | 3.7 | (2.1 to 6.3) | 0.55 | (0.29 to 1.04) | 0.56 | (0.30 to 1.06) |
| Q4 (7502 steps) | 1041 | 8 | 3568 | 2.2 | (1.1 to 4.5) | 0.42 | (0.19 to 0.91) | 0.45 | (0.20 to 0.98) |
| *p for trend* ‡ |  |  |  |  |  | 0.003 | | 0.006 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 4,153 |  |  |  |  | 0.80 | (0.67 to 0.93) | 0.81 | (0.67 to 0.95) |
| < 5000 steps | 2,932 |  |  |  |  | 0.74 | (0.52 to 0.96) | 0.75 | (0.53 to 0.97) |
| ≥ 5000 steps | 1,221 |  |  |  |  | 1.10 | (0.79 to 1.42) | 1.18 | (0.81 to 1.54) |
| **Frailty** § |  | | | | | | | | |
| Q1 (1512 steps) | 255 | 19 | 846 | 22.5 | (14.3 to 35.2) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (2486 steps) | 256 | 13 | 858 | 15.1 | (8.8 to 26.1) | 0.93 | (0.45 to 1.92) | 0.83 | (0.40 to 1.74) |
| Q3 (3705 steps) | 256 | 7 | 870 | 8.0 | (3.8 to 16.9) | 0.62 | (0.25 to 1.52) | 0.60 | (0.24 to 1.49) |
| Q4 (6434 steps) | 258 | 1 | 885 | 1.1 | (0.2 to 8.0) | 0.11 | (0.01 to 0.84) | 0.10 | (0.01 to 0.78) |
| *p for trend* ‡ |  |  |  |  |  | 0.012 | | 0.010 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 1,025 |  |  |  |  | 0.65 | (0.37 to 0.92) | 0.63 | (0.35 to 0.91) |
| < 2500 steps | 384 |  |  |  |  | 0.84 | (0.03 to 1.76) | 0.85 | (0.03 to 1.79) |
| ≥ 2500 steps | 641 |  |  |  |  | 0.21 | (0.06 to 0.92) | 0.26 | (0.07 to 0.99) |
| **Non-frailty** § |  | | | | | | | | |
| Q1 (1923 steps) | 779 | 32 | 2595 | 12.3 | (8.7 to 17.4) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3231 steps) | 783 | 14 | 2650 | 5.3 | (3.1 to 8.9) | 0.77 | (0.40 to 1.47) | 0.78 | (0.40 to 1.51) |
| Q3 (4692 steps) | 782 | 8 | 2666 | 3.0 | (1.5 to 6.0) | 0.51 | (0.23 to 1.14) | 0.54 | (0.24 to 1.20) |
| Q4 (7785 steps) | 784 | 7 | 2684 | 2.6 | (1.2 to 5.5) | 0.62 | (0.26 to 1.48) | 0.69 | (0.28 to 1.65) |
| *p for trend* ‡ |  |  |  |  |  | 0.065 | | 0.104 | |
| 1000 steps increment |  |  |  |  |  |  |  |  |  |
| Total | 3,128 |  |  |  |  | 0.85 | (0.70 to 1.01) | 0.87 | (0.71 to 1.03) |
| < 5000 steps | 2,108 |  |  |  |  | 0.67 | (0.37 to 0.96) | 0.67 | (0.37 to 0.97) |
| ≥ 5000 steps | 1,020 |  |  |  |  | 1.12 | (0.80 to 1.44) | 1.18 | (0.81 to 1.54) |

PY, person-years; CI, confidence interval; HR, hazard ratio; Q, quartiles; Ref, reference. Q1 through Q4 include daily step counts of <2436, 2437–3653, 3654–5378, and ≥5379 steps, respectively, in total participants; <2027, 2028–3019, 3021–4473, and ≥4474 steps, respectively, in frail individuals; and <2620, 2621–3892, 3893–5640, and ≥5642 steps, respectively, in non-frail individuals. The step counts are expressed as quartiles (mean values).

\* Model 1: Adjusted for age, sex, population density, and season of wear.

† Model 2: Adjusted for Model 1 and body mass index, smoking status, alcohol consumption status, family structure, educational attainment, economic status, denture use, medication use, number of chronic diseases, and frailty status.

‡ Linear trend *p*-values were calculated using the likelihood ratio test and a continuous variable of daily step counts.

§ Variables (frailty) used for subgroup analysis were excluded from the adjustment for covariate variables in the model.

**Supplemental Table 4**. Hazard ratios for daily step counts and all-cause mortality calculated using age- and sex-stratified multivariable Cox proportional hazards analysis

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Step counts | *n* | Event | PY | Event/1000 PY | | Model 1 \* | | Model 2 † | |
| Rate | 95% CI | HR | 95% CI | HR | 95% CI |
| ***Women*** |  |  |  |  |  |  |  |  |  |
| Q1 (1790 steps) | 507 | 17 | 1700 | 10.0 | (6.2 to 16.1) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (2862 steps) | 507 | 10 | 1706 | 5.9 | (3.2 to 10.9) | 1.01 | (0.45 to 2.25) | 0.81 | (0.36 to 1.84) |
| Q3 (4106 steps) | 507 | 4 | 1722 | 2.3 | (0.9 to 6.2) | 0.52 | (0.17 to 1.59) | 0.45 | (0.14 to 1.41) |
| Q4 (6817 steps) | 507 | 5 | 1737 | 2.9 | (1.2 to 6.9) | 0.90 | (0.31 to 2.59) | 0.79 | (0.26 to 2.33) |
| ***Men*** |  |  |  |  |  |  |  |  |  |
| Q1 (1787 steps) | 534 | 46 | 1741 | 26.4 | (19.8 to 35.3) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3229 steps) | 534 | 22 | 1800 | 12.2 | (8.0 to 18.6) | 0.79 | (0.47 to 1.33) | 0.85 | (0.50 to 1.44) |
| Q3 (4835 steps) | 534 | 6 | 1824 | 3.3 | (1.5 to 7.3) | 0.28 | (0.12 to 0.67) | 0.30 | (0.12 to 0.71) |
| Q4 (8045 steps) | 535 | 3 | 1832 | 1.6 | (0.5 to 5.1) | 0.18 | (0.06 to 0.61) | 0.21 | (0.06 to 0.72) |
| *p for between groups* |  |  |  |  |  | <0.001 | | 0.072 | |
| ***<75 years*** |  |  |  |  |  |  |  |  |  |
| Q1 (2044 steps) | 722 | 10 | 2436 | 4.1 | (2.2 to 7.6) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (3413 steps) | 722 | 4 | 2445 | 1.6 | (0.6 to 4.4) | 0.47 | (0.15 to 1.51) | 0.65 | (0.19 to 2.28) |
| Q3 (4871 steps) | 722 | 0 | 2467 | 0.0 | (0 to 0) | N/A | | N/A | |
| Q4 (7976 steps) | 721 | 1 | 2473 | 0.4 | (0.1 to 2.9) | 0.17 | (0.02 to 1.34) | 0.22 | (0.03 to 1.92) |
| ***≥75 years*** |  |  |  |  |  |  |  |  |  |
| Q1 (1460 steps) | 320 | 37 | 1029 | 35.9 | (26.0 to 49.6) | 1.00 | (Ref) | 1.00 | (Ref) |
| Q2 (2361 steps) | 319 | 27 | 1058 | 25.5 | (17.5 to 37.2) | 0.86 | (0.52 to 1.42) | 0.83 | (0.50 to 1.38) |
| Q3 (3440 steps) | 319 | 20 | 1063 | 18.8 | (12.1 to 29.2) | 0.70 | (0.40 to 1.23) | 0.70 | (0.39 to 1.23) |
| Q4 (6050 steps) | 320 | 14 | 1090 | 12.8 | (7.6 to 21.7) | 0.50 | (0.26 to 0.94) | 0.52 | (0.27 to 1.00) |
| *p for between groups* |  |  |  |  |  | <0.001 | | <0.001 | |

PY, person-years; CI, confidence interval; HR, hazard ratio; Q, quartiles; Ref, reference. Q1 through Q4 include daily step counts of <2360, 2367–3432, 3434–4883, and ≥4892 steps, respectively, in women; <2536, 2537–3944, 3948–5832, and ≥5836 steps, respectively, in men; <2765, 2766–4073, 4077–5801, and ≥5802 steps, respectively, in individuals aged <75 years; and <1951, 1953–2812, 2814–4225, and ≥4226 steps, respectively, in individuals aged ≥75 years. The step counts are expressed as quartiles (mean values).

\* Model 1: Adjusted for age, sex, population density, and season of wear.

† Model 2: Adjusted for Model 1 and body mass index, smoking status, alcohol consumption status, family structure, educational attainment, economic status, denture use, medication use, number of chronic diseases, and frailty status.