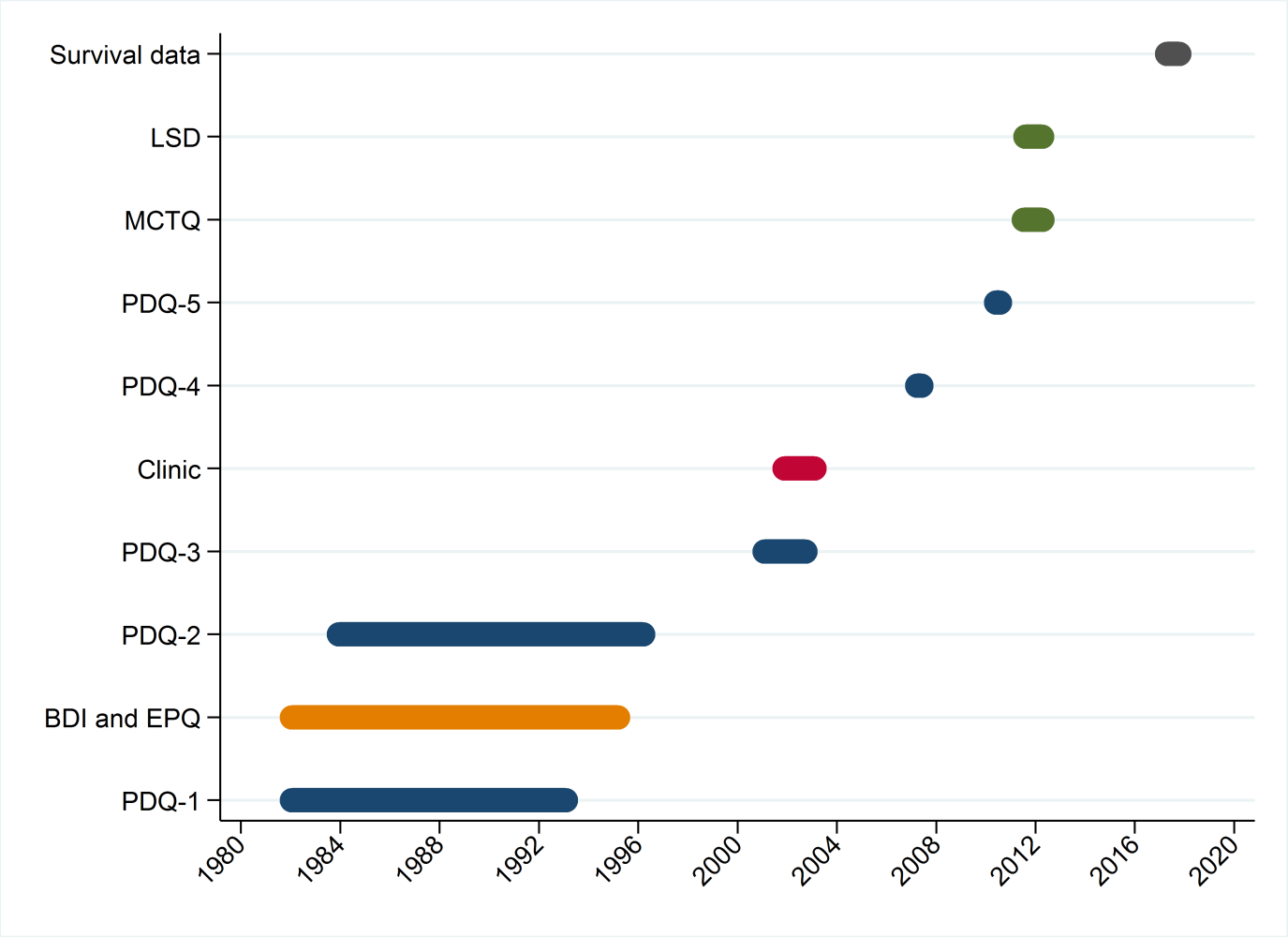
Longitudinal Change of Sleep Timing: Association between Chronotype and Longevity in Older Adults

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Supplementary Materials

**Figure S1:** Longitudinal project timeline



**PDQ**: Personal Details Questionnaire (blue)

**BDI**: Beck Depression Inventory (orange)

**EPQ**: Eysenck Personality Questionnaire (orange)

**Clinical data** (red)

**MCTQ**: Munich Chronotype Questionnaire (green)

**LSD**: Loughborough Sleep Diary (green)

**NHS Death Certificates** (grey)

**Table S1:** Outliers

Outliers were excluded if the data was out of ‘3\*interquartile range’ or had coding error.

|  |  |  |
| --- | --- | --- |
| **Getting up (n=10,459)** | **Going to bed (n=10,376)** | **Sleep duration (n=10,300)** |
| **4:30-11:00 (n=9)** | **19:00-3:00 (n=9)** | **2.5-12 (n=20)** |
| 12.50  11.50  4.25  4.00 X 4  3.50  2.50 | 18 X 3  4.5  4  3.75  3.5 X 3 | 20.00  2.00 X 13  1.50  1.00 X 5 |

**Table S2:** Personal Details Questionnaires – Time independent variables

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **wave-1** | |
|  |  | **size(n)** | **freq.(%)** |
| **sex** | | 6371 | \* |
|  | male | 1917 | 30.09 |
|  | female | 4454 | 69.91 |
| **social class** | | 5893 | \* |
|  | professional occupations | 289 | 4.90 |
|  | intermediate occupations | 2000 | 33.94 |
|  | skilled non-manual occupations | 1686 | 28.61 |
|  | skilled manual occupations | 1396 | 23.69 |
|  | partly skilled occupations | 468 | 7.94 |
|  | unskilled occupations | 54 | 0.92 |
| **education level** | | 5744 | \* |
|  | pre-primary education | 0 | 0.00 |
|  | primary education | 0 | 0.00 |
|  | lower secondary education | 2313 | 40.27 |
|  | upper secondary education | 1048 | 18.25 |
|  | post secondary non-tertiary education | 1163 | 20.25 |
|  | tertiary education first stage | 1195 | 20.80 |
|  | tertiary education second stage | 25 | 0.44 |
| **birth season** | | 6369 |  |
|  | short day length | 3142 | 49.33 |
|  | long day length | 3227 | 50.67 |
| \* ( χ2 goodness of fit test p-value < 0.05) | |  |  |

**Table S3:** Personal Details Questionnaires – Time dependent variables

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **wave-1** | | **wave-2** | | **wave-3** | | **wave-4** | | **wave-5** | |
|  | **attendance (n)** | 6375 | | 3176 | | 624 | | 751 | | 575 | |
|  |  | **size(n)** | **mean±SD** | **size(n)** | **mean±SD** | **size(n)** | **mean±SD** | **size(n)** | **mean±SD** | **size(n)** | **mean±SD** |
| **age (years)** | | 6355 | 65.19±7.45 | 3150 | 67.87±6.82 | 621 | 76.23±5.70 | 750 | 80.56±5.34 | 572 | 82.88±5.20 |
|  |  | **size(n)** | **freq.(%)** | **size(n)** | **freq.(%)** | **size(n)** | **freq.(%)** | **size(n)** | **freq.(%)** | **size(n)** | **freq.(%)** |
| **marital status** | | 5692 | \* | 2945 | \* | 579 | \* | 745 |  | 570 |  |
|  | single, widowed, divorced, separated | 2365 | 41.55 | 1254 | 42.58 | 252 | 43.52 | 376 | 50.47 | 298 | 52.28 |
|  | married, living with someone | 3327 | 58.45 | 1691 | 57.42 | 327 | 56.48 | 369 | 49.53 | 272 | 47.72 |
| **working status** | | 5651 | \* | 2935 | \* | 579 | \* | 743 | \* | 565 | \* |
|  | unemployed, housewife, retired | 4756 | 84.16 | 2552 | 86.95 | 545 | 94.13 | 653 | 87.89 | 485 | 85.84 |
|  | employed | 895 | 15.84 | 383 | 13.05 | 34 | 5.87 | 90 | 12.11 | 80 | 14.16 |
| **smoking** | | 5669 | \* | 2952 | \* | 574 | \* | 745 | \* | 564 | \* |
|  | no | 4661 | 82.22 | 2520 | 85.37 | 543 | 94.60 | 720 | 96.64 | 542 | 96.10 |
|  | yes | 1008 | 17.78 | 432 | 14.63 | 31 | 5.40 | 25 | 3.36 | 22 | 3.90 |
| **alcohol drinking** | | 5444 | \* | 2903 | \* | 558 | \* | 735 | \* | 559 | \* |
|  | no | 1025 | 18.83 | 1002 | 34.52 | 125 | 22.40 | 215 | 29.25 | 176 | 31.48 |
|  | less than once in a day | 3909 | 71.80 | 1628 | 56.08 | 382 | 68.46 | 382 | 51.97 | 290 | 51.88 |
|  | once in a day or more | 510 | 9.37 | 273 | 9.40 | 51 | 9.14 | 138 | 18.78 | 93 | 16.64 |
| **current health** | | 5659 | \* | 2899 | \* | 578 | \* | 734 | \* | 562 | \* |
|  | very bad | 27 | 0.48 | 10 | 0.34 | 0 | 0.00 | 4 | 0.54 | 4 | 0.71 |
|  | bad | 165 | 2.92 | 70 | 2.41 | 15 | 2.60 | 40 | 5.45 | 28 | 4.98 |
|  | fair | 1418 | 25.06 | 950 | 32.77 | 140 | 24.22 | 235 | 32.02 | 187 | 33.27 |
|  | good | 2642 | 46.69 | 1380 | 47.60 | 312 | 53.98 | 346 | 47.14 | 241 | 42.88 |
|  | very good | 1407 | 24.86 | 489 | 16.87 | 111 | 19.20 | 109 | 14.85 | 102 | 18.15 |
| **usage of sleep medication** | | 5635 | \* | 2978 | \* | 575 | \* | 716 | \* | 558 | \* |
|  | no | 4954 | 87.91 | 2642 | 88.72 | 533 | 92.70 | 672 | 93.85 | 525 | 94.09 |
|  | yes | 681 | 12.09 | 336 | 11.28 | 42 | 7.30 | 44 | 6.15 | 33 | 5.91 |
| **test season** | | 6358 | \* | 3150 | \* | 621 | \* | 751 |  | 572 |  |
|  | short day length | 3661 | 57.58 | 1244 | 39.49 | 453 | 72.95 | 0 | 0.00 | 0 | 0.00 |
|  | long day length | 2697 | 42.42 | 1906 | 60.51 | 168 | 27.05 | 751 | 100.00 | 572 | 100.00 |
| \* ( χ2 goodness of fit test p-value < 0.05) | |  |  |  |  |  |  |  |  |  |  |

**Table S4:** Results of the Munich ChronoType Questionnaire

|  |  |  |  |
| --- | --- | --- | --- |
| **Munich ChronoType Questionnaire (MCTQ)** | | | |
|  |  | **Sample size(n)** | **mean±SD** |
| **age** |  | 450 | 83.63±5.11 |
| **MCTQ** |  |  |  |
|  | midsleep in weekdays | 394 | 3:21±00:47 |
|  | midsleep in free days (corrected) | 382 | 3:24±00:46 |

**Table S5:** Correlation between the MCTQ scores and the PDQ sleep variables

|  |  |  |
| --- | --- | --- |
| **PDQ (wave-5)** | **MCTQ** | **statistics** |
| get up time | wake weekdays | 0.57\*\* |
|  | wake free days | 0.57\*\* |
| go bed time | sleep onset weekdays | 0.63\*\* |
|  | sleep onset free days | 0.62\*\* |
| midsleep | midsleep in free days (corrected) | 0.70\*\* |

PDQ (Personal Details Questionnaire), MCTQ (Munich Chronotype Questionnaire)

Pearson’s correlation; \* (p-value < 0.05) \*\* (p-value < 0.001)

**Table S6:** Correlation between the Loughborough Sleep Diary variables and the PDQ sleep variables

|  |  |  |
| --- | --- | --- |
| **PDQ (wave-5)** | **LSD** | **statistics** |
| get up time | LSD average get up time | 0.80\*\* |
| get up time | LSD average wake time | 0.60\*\* |
| go bed time | LSD average go to bed time | 0.79\*\* |
| go bed time | LSD average sleep onset time | 0.62\*\* |

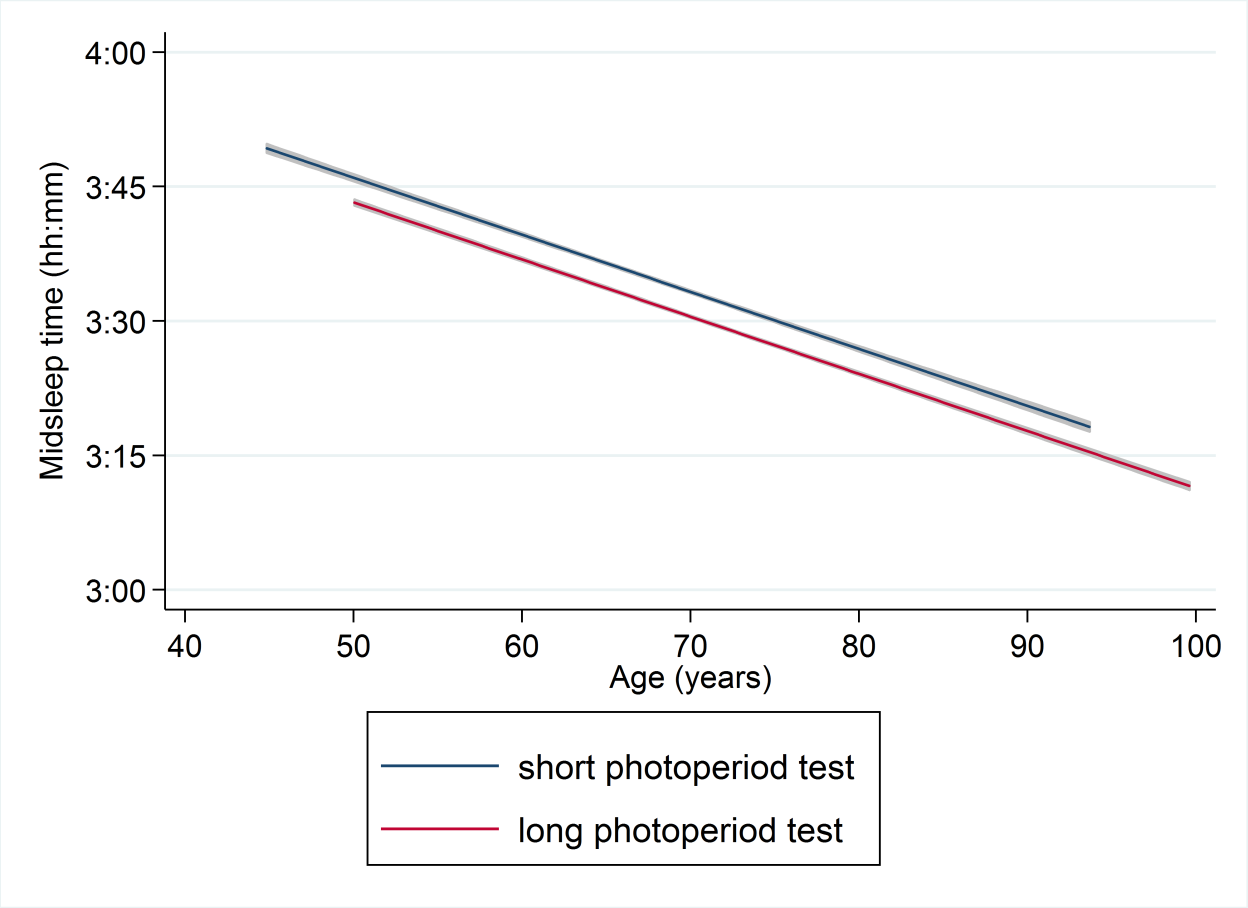
PDQ (Personal Details Questionnaire), LSD (Loughborough Sleep Diary)

Pearson’s correlation; \* (p-value < 0.05) \*\* (p-value < 0.001)

**Table S7.** Latent class analysis for sleep midpoint (1 – 5 class models)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Model** | **BIC** | **ΔBIC** | **Proportion of classes** | | | | | **Mean probability of belonging to cluster** | | | | |
| 1-class | 18181.38 |  | 1.00 |  |  |  |  | 1 |  |  |  |  |
| 2-class | 16822.71 | -1358.67 | 0.38 | 0.62 |  |  |  | 0.85 | 0.88 |  |  |  |
| 3-class | 15713.07 | -1109.64 | 0.54 | 0.31 | 0.16 |  |  | 0.81 | 0.88 | 0.87 |  |  |
| 4-class | 15206.41 | -506.652 | 0.07 | 0.39 | 0.20 | 0.34 |  | 0.88 | 0.77 | 0.87 | 0.81 |  |
| 5-class | 15116.09 | -90.3278 | 0.35 | 0.06 | 0.10 | 0.19 | 0.31 | 0.76 | 0.87 | 0.85 | 0.71 | 0.81 |

**Figure S2:** Change of midsleep time across age for different test season groups in unemployed subgroup



Change of midsleep point across age for different test season groups. The graph includes the unemployed/retired/housewife participants. The blue line represents chronotype of participants whose tests were performed in short photoperiod season. The red line represents chronotype of participants with long photoperiod test season. Fit lines produced by linear mixed models (covariates: sex, working status, marital status, social class, education level, sleep medication, subjective health rating, test season, birth season, sleep duration, smoking, alcohol drinking).

**Table S8:** Latent class analysis for sleep midpoint

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **chronotype clusters** | | |
|  | |  | **M.** | **E.** | **I.** |
| **sample size** | |  | 1631 | 842 | 2874 |
| **constant** | | \* | 3.47 | 4.60 | 4.25 |
| **age** | |  | -0.008 | -0.004 | -0.009 |
| **variance** | | \* | 0.20 | 0.31 | 0.11 |
| **covariates** | |  | (regression coefficients) | | |
| **gender** | |  |  |  |  |
|  | female |  | -0.01 | -0.03 | 0.04 |
| **birth season** | | \* |  |  |  |
|  | long daylength |  | 0.05 | -0.08 | 0.03 |
| **test season** | | \* |  |  |  |
|  | long daylength |  | 0.09 | -0.11 | 0.02 |
| **social class** (ref.: professional) | |  |  |  |  |
|  | intermediate occupations |  | -0.08 | -0.12 | 0.20 |
|  | skilled non-manual occupations |  | -0.08 | -0.15 | 0.23 |
|  | skilled manual occupations |  | -0.11 | 0.05 | 0.05 |
|  | partly skilled occupations |  | 0.02 | 0.05 | -0.08 |
|  | unskilled occupations |  | 0.22 | 0.52 | -0.75 |
| **education level** (ref.: lower secondary) | | \* |  |  |  |
|  | upper-secondary education |  | -0.41 | 0.82 | -0.41 |
|  | post-secondary non-tertiary education |  | -0.54 | 0.82 | -0.28 |
|  | tertiary education first stage |  | -0.25 | 0.59 | -0.34 |
|  | tertiary education second stage |  | 1.57 | -2.85 | 1.28 |
| **working status** | | \* |  |  |  |
|  | employed |  | 0.31 | -0.12 | -0.19 |
| **marital status** | | \* |  |  |  |
|  | married, living with someone |  | -0.02 | -0.11 | 0.13 |
| **smoking** | | \* |  |  |  |
|  | non-smoking |  | 0.10 | -0.25 | 0.15 |
| **alcohol drinking** (ref.: not drinking) | | \* |  |  |  |
|  | less than once in a day |  | -0.06 | -0.08 | 0.14 |
|  | once in a day or more |  | -0.23 | 0.34 | -0.11 |
| **current health** (ref.: very bad) | | \* |  |  |  |
|  | Bad |  | 0.02 | 0.02 | -0.04 |
|  | Fair |  | -0.11 | -0.05 | 0.15 |
|  | Good |  | -0.08 | -0.26 | 0.34 |
|  | Very good |  | 0.08 | -0.23 | 0.15 |
| **usage of sleep medication** | | \* |  |  |  |
|  | not using |  | 0.06 | -0.11 | 0.05 |
| Number of cases=5347, number of replications=9440, log-likelihood=-7620.47, BIC= 15713.07, AIC= 15350.93  M. (morning-type, earlier sleep midpoint), E. (evening-type, later sleep midpoint), I. (intermediate sleep midpoint)  \* (Wald test p-value < 0.05) | | | | | |

**Table S9:** Comparison of daily habits between chronotype latent classes

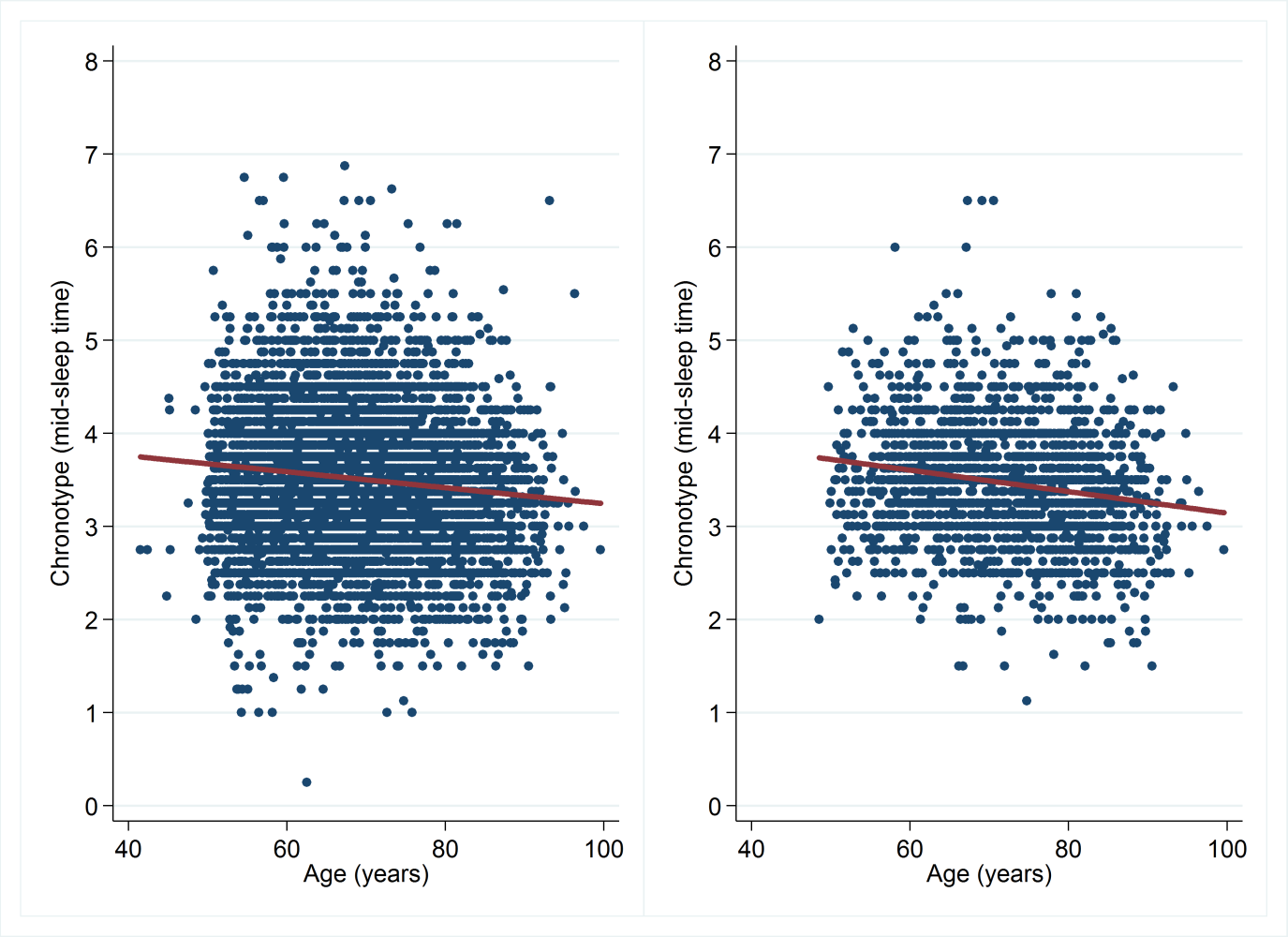
Data collected in the first wave. Bivariate comparisons using ANOVA for continuous variable (means reported in the table), Chi-squared test for categorical variables (frequencies reported).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Morning-type** | | **Intermediate** | **Evening-type** | **p-value** |
| **Sample size** | 1631 | 2874 | | 842 |  |
| **Eysenck personality score** |  |  | |  |  |
| Extraversion personality | 11.26 | 11.54 | | 11.95 | 0.038 |
| Neuroticism personality | 10.37 | 10.40 | | 10.64 | 0.617 |
| Psychoticism personality | 1.82 | 1.67 | | 2.23 | 0.000 |
| **Number of children** | 1.93 | 1.87 | | 1.87 | 0.350 |
| **Number of people in household** | 1.90 | 1.85 | | 1.82 | 0.074 |
| **Main occupation** |  |  | |  |  |
| Managers, directors and senior official | 11.34 | 12.06 | | 11.99 | 0.765 |
| Professional | 19.45 | 17.49 | | 14.87 | 0.017 |
| Associate professional and technical | 19.27 | 18.86 | | 17.15 | 0.425 |
| Administrative and secretarial | 23.23 | 26.39 | | 29.38 | 0.003 |
| Skilled trades | 5.39 | 5.89 | | 6.12 | 0.710 |
| Caring, leisure and other service | 3.97 | 3.65 | | 4.56 | 0.479 |
| Sales and customer service | 4.46 | 6.03 | | 3.96 | 0.016 |
| Process, plant and machine operatives | 4.52 | 4.31 | | 6.59 | 0.021 |
| Elementary | 8.36 | 5.33 | | 5.40 | 0.000 |
| **Further education** (yes) | 49.56 | 49.29 | | 51.46 | 0.544 |
| **Total education years** (years) | 13.77 | 13.49 | | 13.43 | 0.014 |
| **General health and depression** |  |  | |  |  |
| Number of medication taken in a day | 0.81 | 0.88 | | 1.03 | 0.000 |
| Beck Depression Inventory score | 7.78 | 7.23 | | 8.00 | 0.001 |
| Mild to severe depression (yes) | 29.76 | 26.59 | | 31.84 | 0.007 |
| **Have you ever smoked** (yes) | 59.34 | 63.43 | | 73.17 | 0.000 |
| **How many years did you smoked** (years) | 15.03 | 16.69 | | 23.05 | 0.000 |
| **Have you ever drink alcohol** (yes) | 81.68 | 88.05 | | 88.57 | 0.000 |
| **Total daily difficulty score** (0-12) | 1.22 | 1.15 | | 1.67 | 0.000 |
| Difficulty doing household tasks (no) | 82.35 | 83.65 | | 73.78 | 0.000 |
| Difficulty doing thing around house (no) | 84.38 | 85.12 | | 77.51 | 0.000 |
| Difficulty bathing self (no) | 95.09 | 95.44 | | 92.59 | 0.005 |
| Difficulty household cleaning (no) | 81.46 | 82.50 | | 75.93 | 0.000 |
| Difficulty doing laundry (no) | 92.39 | 93.30 | | 88.90 | 0.000 |
| Difficulty preparing meals (no) | 95.03 | 96.19 | | 94.48 | 0.063 |
| Difficulty dressing (no) | 97.06 | 97.50 | | 94.71 | 0.000 |
| Difficulty climbing stairs (no) | 78.76 | 80.75 | | 71.91 | 0.000 |
| Difficulty going outdoors (no) | 95.78 | 95.48 | | 92.96 | 0.006 |
| Difficulty cutting toenails (no) | 77.71 | 77.19 | | 71.13 | 0.001 |
| Difficulty getting about locally (no) | 93.13 | 93.55 | | 88.86 | 0.000 |
| Difficulty travelling long distances (no) | 87.47 | 88.15 | | 84.43 | 0.022 |
| **Daily activities** |  |  | |  |  |
| Activity: Resting, napping (hours per month) | 120.77 | 131.98 | | 145.36 | 0.000 |
| Activity: Requiring little physical effort (hpm) | 70.88 | 68.29 | | 73.36 | 0.007 |
| Activity: Non-strenuous hobbies (hpm) | 25.23 | 24.97 | | 24.67 | 0.938 |
| Activity: Personal care/cooking and eating (hpm) | 81.08 | 84.25 | | 81.60 | 0.032 |
| Activity: Light housework/gardening (hpm) | 36.48 | 37.38 | | 37.28 | 0.561 |
| Activity: Heavy housework/gardening (hpm) | 24.53 | 24.76 | | 22.27 | 0.055 |
| Activity: Outings (hpm) | 41.55 | 39.57 | | 38.77 | 0.147 |
| Activity: Visiting friends and relatives (hpm) | 29.93 | 32.07 | | 30.50 | 0.212 |
| Activity: Using public transport (hpm) | 12.89 | 12.49 | | 13.07 | 0.747 |
| Activity: Driving a car (hpm) | 13.45 | 12.49 | | 12.08 | 0.294 |
| Activity: Socializing and entertaining (hpm) | 27.45 | 30.61 | | 33.91 | 0.000 |
| Activity: Going on holiday (weeks per year) | 2.39 | 2.69 | | 2.43 | 0.011 |
| Activity: Light exercise (hpm) | 25.79 | 26.83 | | 24.31 | 0.073 |
| Activity: Strenuous exercise (hpm) | 3.72 | 2.83 | | 2.72 | 0.004 |
| Doing exercise (yes) | 83.31 | 85.52 | | 78.47 | 0.000 |
| **Do you keep any pets** (yes) | 29.15 | 25.11 | | 30.46 | 0.001 |
| **Meal times and sleep** |  |  | |  |  |
| Getting up time (hh:mm) | 7:10 | 8:00 | | 8:41 | 0.000 |
| Going to bed time (hh:mm) | 22:39 | 23:18 | | 00:14 | 0.000 |
| Sleep duration (hours) | 6.95 | 7.03 | | 6.86 | 0.001 |
| How many times do you wake during night | 1.38 | 1.36 | | 1.32 | 0.541 |
| Do you have sleeping difficulty (yes) | 31.63 | 35.03 | | 43.01 | 0.000 |
| Breakfast time (hh:mm) | 7:52 | 8:31 | | 9:09 | 0.000 |
| Lunch time (hh:mm) | 12:31 | 12:39 | | 12:55 | 0.000 |
| Dinner time (hh:mm) | 17:49 | 17:50 | | 18:07 | 0.000 |

**Table S10.** Depression and chronotype clusters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | | | **BDI score** | |
| **Constant** | | | | 12.52[9.44/15.59]\*\* | |
| **Chronotype latent classes** (ref.: morning-type) | | | |  | |
|  | intermediate | | | -0.39[-0.75/-0.03]\* | |
|  | evening | | | -0.18[-0.67/0.30] | |
| **Gender** | | | |  | |
|  | female | | | 1.26[0.88/1.64]\*\* | |
| **Age** | | | | -0.01[-0.04/0.01] | |
| **Birth season** | | | |  | |
|  | long photoperiod | | | -0.07[-0.38/0.24] | |
| **Test season** | | | |  | |
|  | long photoperiod | | | -0.28[-0.59/0.04] | |
| **Social class** (ref.: professional) | | | |  | |
|  | intermediate occupations | | | 0.13[-0.63/0.90] | |
|  | skilled non-manual occupations | | | 0.88[0.03/1.74]\* | |
|  | skilled manual occupations | | | 0.63[-0.22/1.49] | |
|  | partly skilled occupations | | | 0.88[-0.12/1.89] | |
|  | unskilled occupations | | | 2.78[0.80/4.76]\* | |
| **Education level** (ref.: lower secondary) | | | |  | |
|  | upper-secondary education | | | -0.43[-0.88/0.02] | |
|  | post-secondary non-tertiary edu. | | | -0.59[-1.03/-0.14]\* | |
|  | tertiary education first stage | | | -0.62[-1.14/-0.09]\* | |
|  | tertiary education second stage | | | 1.18[-1.13/3.48] | |
| **Working status** | | | |  | |
|  | employed | | | 0.33[-0.14/0.80] | |
| **Marital status** | | | |  | |
|  | married, living with someone | | | -0.88[-1.22/-0.54]\*\* | |
| **General health rating** (ref.: very bad) | | | |  | |
|  | Bad | | | 1.14[-1.48/3.76] | |
|  | Fair | | | -2.07[-4.53/0.40] | |
|  | Good | | | -4.90[-7.36/-2.45]\*\* | |
|  | Very good | | | -6.53[-9.00/-4.07]\*\* | |
| Results were reported as regression coefficient [95% Confidence interval]. Ref.: Reference variable. BDI: Beck Depression Inventory  Linear regression, number of observations= 4774, F(21,4752)=38.53, p-value<0.001, R-squared=0.146  \* (regression p-value < 0.05), \*\* (regression p-value < 0.001) | | | | | |
|  | | **Morning-type** | **Intermediate** | | **Evening-type** |
| **No depression** | | 70.24% | 73.41% | | 68.16% |
| **Mild to moderate** | | 22.96% | 22.22% | | 25.63% |
| **Moderate to severe** | | 5.50% | 3.53% | | 5.68% |
| **Severe** | | 1.29% | 0.84% | | 0.53% |
| Chi2(6)=20.51, p=0.002 | | | | | |

**Figure S3:** Sensitivity analysis for clinical investigation subgroup

****

The first graph includes all participants. The second graph shows the longitudinal decline of the chronotype for individuals who attended clinical investigation. Blue dots show all available chronotype data. Red lines are fit lines produced by linear mixed models (covariates: sex, working status, marital status, social class, education level, sleep medication, subjective health rating, test season, birth season, sleep duration, smoking, alcohol drinking). The first model: Slope of the fit line is -0.010, p<0.001 (number of participants=5284, number of available data=9260, Wald(24)=564.40, p<0.001). The second model: Slope of the fit line is -0.012, p<0.001 (number of participants=544, number of available data=1898, Wald(24)=227.27, p<0.001).

**Table S11.** Results of clinic investigation

|  |  |
| --- | --- |
|  |  |
| Sample size | 555 |
| Age | 76.16±5.51 |
|  | **mean±SD** |
| systolic blood pressure [mmHg] | 155.63±22.16 |
| diastolic blood pressure [mmHg] | 81.58±11.59 |
| heart rate | 74.69±12.53 |
| weight [kg] | 68.90±13.11 |
| body mass index [kg/m2] | 26.09±4.13 |
| waist circumferences [cm] | 86.11±11.92 |
| glycosylated haemoglobin (HbA1c) [%] | 5.49±0.59 |
| total cholesterol [mmol/L] | 5.63±1.12 |
| high-density lipoprotein cholesterol [mmol/L] | 1.56±0.46 |
| total cholesterol/HDL | 3.83±1.07 |

**Table S12:** Results of logistic regression analysis for high blood pressure risk, high blood sugar risk, obesity risk and high cholesterol risk

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **High blood pressure (a)** | **High blood sugar (b)** | **Obesity (c)** | **High  cholesterol (d)** |
| **constant** | 0.02[0.00/0.38]\* | 0.03[0.00/8.81] | 1.74[0.15/19.96] | 28.69[0.96/853.17] |
| **age** | 1.06[1.02/1.10]\* | 1.01[0.94/1.08] | 0.99[0.96/1.03] | 0.97[0.93/1.01] |
| **gender** (female) | 1.12[0.73/1.73] | 0.92[0.40/2.12] | 0.90[0.62/1.31] | 1.29[0.78/2.12] |
| **chronotype cluster** (ref: morning-type) |  |  |  |  |
| **intermediate** | 1.52[0.98/2.35] | 1.09[0.42/2.86] | 1.14[0.78/1.67] | 1.61[0.96/2.71] |
| **evening-type** | 1.88[1.02/3.47]\* | 2.11[0.71/6.30] | 1.21[0.73/2.02] | 1.59[0.77/3.31] |
| Presented as odds ratio[95%CI]  \* (regression p-value < 0.05), \*\* (regression p-value < 0.001)  a. Logistic regression; number of observation=529; likelihood-ratio chi-squared(4)=16.26, p=0.0027; pseudo R-squared=0.027  b. Logistic regression; number of observation=443; likelihood-ratio chi-squared(4)=2.15, p=0.71; pseudo R-squared=0.011  c. Logistic regression; number of observation=531; likelihood-ratio chi-squared(4)=1.13, p=0.89; pseudo R-squared=0.002  d. Logistic regression; number of observation=445; likelihood-ratio chi-squared(4)=5.90, p=0.21; pseudo R-squared=0.014 | | | | |

**Table S13:** Life table of the cohort

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **year** | **number at start** | **deaths** | **withdrawn** | **survival** | **std.error** | **[95% conf. int.]** | |
| 0 1 | 5987 | 45 | 0 | 0.9925 | 0.0011 | 0.9899 0.9944 | |
| 1 2 | 5942 | 88 | 0 | 0.9778 | 0.0019 | 0.9737 0.9812 | |
| 2 3 | 5854 | 91 | 0 | 0.9626 | 0.0025 | 0.9575 0.9671 | |
| 3 4 | 5763 | 90 | 0 | 0.9476 | 0.0029 | 0.9416 0.9529 | |
| 4 5 | 5673 | 119 | 0 | 0.9277 | 0.0033 | 0.9208 0.9340 | |
| 5 6 | 5554 | 119 | 0 | 0.9078 | 0.0037 | 0.9002 0.9149 | |
| 6 7 | 5435 | 163 | 0 | 0.8806 | 0.0042 | 0.8721 0.8885 | |
| 7 8 | 5272 | 146 | 0 | 0.8562 | 0.0045 | 0.8470 0.8648 | |
| 8 9 | 5126 | 153 | 0 | 0.8306 | 0.0048 | 0.8209 0.8399 | |
| 9 10 | 4973 | 149 | 0 | 0.8057 | 0.0051 | 0.7955 0.8155 | |
| 10 11 | 4824 | 165 | 0 | 0.7782 | 0.0054 | 0.7674 0.7885 | |
| 11 12 | 4659 | 171 | 0 | 0.7496 | 0.0056 | 0.7385 0.7604 | |
| 12 13 | 4488 | 171 | 0 | 0.7211 | 0.0058 | 0.7095 0.7322 | |
| 13 14 | 4317 | 199 | 0 | 0.6878 | 0.006 | 0.6759 0.6994 | |
| 14 15 | 4118 | 174 | 0 | 0.6588 | 0.0061 | 0.6466 0.6706 | |
| 15 16 | 3944 | 184 | 0 | 0.628 | 0.0062 | 0.6156 0.6401 | |
| 16 17 | 3760 | 206 | 0 | 0.5936 | 0.0063 | 0.5811 0.6059 | |
| 17 18 | 3554 | 189 | 0 | 0.5621 | 0.0064 | 0.5494 0.5745 | |
| 18 19 | 3365 | 198 | 0 | 0.529 | 0.0065 | 0.5163 0.5415 | |
| 19 20 | 3167 | 191 | 0 | 0.4971 | 0.0065 | 0.4843 0.5097 | |
| 20 21 | 2976 | 203 | 0 | 0.4632 | 0.0064 | 0.4505 0.4757 | |
| 21 22 | 2773 | 211 | 0 | 0.4279 | 0.0064 | 0.4154 0.4404 | |
| 22 23 | 2562 | 177 | 0 | 0.3984 | 0.0063 | 0.3859 0.4107 | |
| 23 24 | 2385 | 213 | 0 | 0.3628 | 0.0062 | 0.3506 0.3750 | |
| 24 25 | 2172 | 183 | 17 | 0.3321 | 0.0061 | 0.3202 0.3441 | |
| 25 26 | 1972 | 185 | 32 | 0.3007 | 0.0059 | 0.2891 0.3124 | |
| 26 27 | 1755 | 158 | 58 | 0.2732 | 0.0058 | 0.2619 0.2845 | |
| 27 28 | 1539 | 145 | 179 | 0.2458 | 0.0056 | 0.2349 0.2569 | |
| 28 29 | 1215 | 146 | 173 | 0.214 | 0.0055 | 0.2034 0.2249 | |
| 29 30 | 896 | 105 | 67 | 0.188 | 0.0054 | 0.1776 0.1986 | |
| 30 31 | 724 | 84 | 20 | 0.1659 | 0.0053 | 0.1557 0.1763 | |
| 31 32 | 620 | 64 | 143 | 0.1465 | 0.0052 | 0.1365 0.1568 | |
| 32 33 | 413 | 37 | 227 | 0.1284 | 0.0053 | 0.1182 0.1390 | |
| 33 34 | 149 | 18 | 18 | 0.1119 | 0.0059 | 0.1007 0.1238 | |
| 34 35 | 113 | 6 | 106 | 0.1007 | 0.0068 | 0.0878 0.1146 | |
| 35 36 | 1 | 1 | 0 | 0 |  |  |  |

**Figure S4:** Survival graph of the whole cohort during the follow-up years

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**Table S14:** Life table of the morning cluster

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **year** | **number at start** | **deaths** | **withdrawn** | **survival** | **std.error** | **[95% conf. int.]** |
| 0 1 | 1569 | 8 | 0 | 0.9949 | 0.0018 | 0.9898 0.9974 |
| 1 2 | 1561 | 18 | 0 | 0.9834 | 0.0032 | 0.9758 0.9887 |
| 2 3 | 1543 | 15 | 0 | 0.9739 | 0.004 | 0.9647 0.9807 |
| 3 4 | 1528 | 14 | 0 | 0.9649 | 0.0046 | 0.9546 0.9730 |
| 4 5 | 1514 | 17 | 0 | 0.9541 | 0.0053 | 0.9425 0.9634 |
| 5 6 | 1497 | 29 | 0 | 0.9356 | 0.0062 | 0.9223 0.9467 |
| 6 7 | 1468 | 37 | 0 | 0.912 | 0.0072 | 0.8969 0.9250 |
| 7 8 | 1431 | 37 | 0 | 0.8885 | 0.0079 | 0.8718 0.9031 |
| 8 9 | 1394 | 33 | 0 | 0.8674 | 0.0086 | 0.8496 0.8833 |
| 9 10 | 1361 | 40 | 0 | 0.8419 | 0.0092 | 0.8229 0.8591 |
| 10 11 | 1321 | 35 | 0 | 0.8196 | 0.0097 | 0.7997 0.8378 |
| 11 12 | 1286 | 43 | 0 | 0.7922 | 0.0102 | 0.7713 0.8115 |
| 12 13 | 1243 | 42 | 0 | 0.7655 | 0.0107 | 0.7437 0.7856 |
| 13 14 | 1201 | 37 | 0 | 0.7419 | 0.011 | 0.7195 0.7628 |
| 14 15 | 1164 | 42 | 0 | 0.7151 | 0.0114 | 0.6921 0.7368 |
| 15 16 | 1122 | 42 | 0 | 0.6883 | 0.0117 | 0.6648 0.7106 |
| 16 17 | 1080 | 58 | 0 | 0.6514 | 0.012 | 0.6272 0.6744 |
| 17 18 | 1022 | 45 | 0 | 0.6227 | 0.0122 | 0.5982 0.6462 |
| 18 19 | 977 | 46 | 0 | 0.5934 | 0.0124 | 0.5686 0.6172 |
| 19 20 | 931 | 56 | 0 | 0.5577 | 0.0125 | 0.5327 0.5819 |
| 20 21 | 875 | 55 | 0 | 0.5226 | 0.0126 | 0.4976 0.5470 |
| 21 22 | 820 | 55 | 0 | 0.4876 | 0.0126 | 0.4626 0.5120 |
| 22 23 | 765 | 42 | 0 | 0.4608 | 0.0126 | 0.4360 0.4853 |
| 23 24 | 723 | 55 | 0 | 0.4257 | 0.0125 | 0.4012 0.4501 |
| 24 25 | 668 | 41 | 3 | 0.3996 | 0.0124 | 0.3753 0.4237 |
| 25 26 | 624 | 51 | 10 | 0.3666 | 0.0122 | 0.3428 0.3905 |
| 26 27 | 563 | 46 | 18 | 0.3362 | 0.012 | 0.3128 0.3597 |
| 27 28 | 499 | 39 | 62 | 0.3082 | 0.0118 | 0.2852 0.3314 |
| 28 29 | 398 | 39 | 49 | 0.276 | 0.0116 | 0.2535 0.2990 |
| 29 30 | 310 | 35 | 17 | 0.244 | 0.0115 | 0.2218 0.2667 |
| 30 31 | 258 | 24 | 8 | 0.2209 | 0.0113 | 0.1991 0.2434 |
| 31 32 | 226 | 15 | 46 | 0.2046 | 0.0112 | 0.1830 0.2270 |
| 32 33 | 165 | 11 | 93 | 0.1856 | 0.0116 | 0.1635 0.2088 |
| 33 34 | 61 | 6 | 6 | 0.1664 | 0.0127 | 0.1423 0.1922 |
| 34 35 | 49 | 1 | 47 | 0.1599 | 0.0138 | 0.1339 0.1879 |
| 35 36 | 1 | 1 | 0 | 0 |  |  |

**Table S15:** Life table of the intermediate chronotype cluster

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **year** | **number at start** | **deaths** | **withdrawn** | **survival** | **std.error** | **[95% conf. int.]** | |
| 0 1 | 2808 | 20 | 0 | 0.9929 | 0.0016 | 0.989 | 0.9954 |
| 1 2 | 2788 | 35 | 0 | 0.9804 | 0.0026 | 0.9746 | 0.9849 |
| 2 3 | 2753 | 36 | 0 | 0.9676 | 0.0033 | 0.9603 | 0.9735 |
| 3 4 | 2717 | 44 | 0 | 0.9519 | 0.004 | 0.9433 | 0.9592 |
| 4 5 | 2673 | 55 | 0 | 0.9323 | 0.0047 | 0.9224 | 0.941 |
| 5 6 | 2618 | 54 | 0 | 0.9131 | 0.0053 | 0.9021 | 0.9229 |
| 6 7 | 2564 | 71 | 0 | 0.8878 | 0.006 | 0.8756 | 0.8989 |
| 7 8 | 2493 | 66 | 0 | 0.8643 | 0.0065 | 0.8511 | 0.8765 |
| 8 9 | 2427 | 74 | 0 | 0.838 | 0.007 | 0.8238 | 0.8511 |
| 9 10 | 2353 | 61 | 0 | 0.8162 | 0.0073 | 0.8014 | 0.8301 |
| 10 11 | 2292 | 76 | 0 | 0.7892 | 0.0077 | 0.7736 | 0.8038 |
| 11 12 | 2216 | 78 | 0 | 0.7614 | 0.008 | 0.7452 | 0.7767 |
| 12 13 | 2138 | 78 | 0 | 0.7336 | 0.0083 | 0.7169 | 0.7496 |
| 13 14 | 2060 | 95 | 0 | 0.6998 | 0.0086 | 0.6825 | 0.7164 |
| 14 15 | 1965 | 86 | 0 | 0.6692 | 0.0089 | 0.6514 | 0.6862 |
| 15 16 | 1879 | 109 | 0 | 0.6303 | 0.0091 | 0.6122 | 0.6479 |
| 16 17 | 1770 | 95 | 0 | 0.5965 | 0.0093 | 0.5781 | 0.6144 |
| 17 18 | 1675 | 79 | 0 | 0.5684 | 0.0093 | 0.5498 | 0.5865 |
| 18 19 | 1596 | 97 | 0 | 0.5338 | 0.0094 | 0.5152 | 0.5521 |
| 19 20 | 1499 | 87 | 0 | 0.5028 | 0.0094 | 0.4842 | 0.5212 |
| 20 21 | 1412 | 98 | 0 | 0.4679 | 0.0094 | 0.4494 | 0.4863 |
| 21 22 | 1314 | 102 | 0 | 0.4316 | 0.0093 | 0.4132 | 0.4499 |
| 22 23 | 1212 | 85 | 0 | 0.4014 | 0.0093 | 0.3832 | 0.4194 |
| 23 24 | 1127 | 95 | 0 | 0.3675 | 0.0091 | 0.3497 | 0.3853 |
| 24 25 | 1032 | 98 | 9 | 0.3325 | 0.0089 | 0.3151 | 0.3499 |
| 25 26 | 925 | 92 | 20 | 0.299 | 0.0087 | 0.2822 | 0.3161 |
| 26 27 | 813 | 67 | 26 | 0.274 | 0.0085 | 0.2575 | 0.2907 |
| 27 28 | 720 | 76 | 78 | 0.2434 | 0.0082 | 0.2275 | 0.2596 |
| 28 29 | 566 | 81 | 91 | 0.2055 | 0.0079 | 0.1902 | 0.2213 |
| 29 30 | 394 | 48 | 37 | 0.1793 | 0.0078 | 0.1643 | 0.1948 |
| 30 31 | 309 | 42 | 9 | 0.1545 | 0.0076 | 0.14 | 0.1697 |
| 31 32 | 258 | 35 | 59 | 0.1309 | 0.0074 | 0.1168 | 0.1458 |
| 32 33 | 164 | 19 | 85 | 0.1104 | 0.0076 | 0.0961 | 0.1258 |
| 33 34 | 60 | 8 | 10 | 0.0943 | 0.0083 | 0.0788 | 0.1115 |
| 34 35 | 42 | 5 | 37 | 0.0743 | 0.0103 | 0.0557 | 0.0962 |

**Table S16:** Life table of the evening cluster

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **year** | **number at start** | **deaths** | **withdrawn** | **survival** | **std.error** | **[95% conf. int.]** | |
| 0 1 | 820 | 6 | 0 | 0.9927 | 0.003 | 0.9838 | 0.9967 |
| 1 2 | 814 | 8 | 0 | 0.9829 | 0.0045 | 0.9713 | 0.9899 |
| 2 3 | 806 | 12 | 0 | 0.9683 | 0.0061 | 0.9538 | 0.9783 |
| 3 4 | 794 | 15 | 0 | 0.95 | 0.0076 | 0.9327 | 0.9629 |
| 4 5 | 779 | 27 | 0 | 0.9171 | 0.0096 | 0.896 | 0.934 |
| 5 6 | 752 | 9 | 0 | 0.9061 | 0.0102 | 0.884 | 0.9242 |
| 6 7 | 743 | 29 | 0 | 0.8707 | 0.0117 | 0.8458 | 0.8919 |
| 7 8 | 714 | 20 | 0 | 0.8463 | 0.0126 | 0.8198 | 0.8693 |
| 8 9 | 694 | 21 | 0 | 0.8207 | 0.0134 | 0.7927 | 0.8453 |
| 9 10 | 673 | 26 | 0 | 0.789 | 0.0142 | 0.7595 | 0.8154 |
| 10 11 | 647 | 33 | 0 | 0.7488 | 0.0151 | 0.7176 | 0.777 |
| 11 12 | 614 | 26 | 0 | 0.7171 | 0.0157 | 0.6849 | 0.7466 |
| 12 13 | 588 | 25 | 0 | 0.6866 | 0.0162 | 0.6536 | 0.7171 |
| 13 14 | 563 | 36 | 0 | 0.6427 | 0.0167 | 0.6088 | 0.6744 |
| 14 15 | 527 | 20 | 0 | 0.6183 | 0.017 | 0.5841 | 0.6506 |
| 15 16 | 507 | 12 | 0 | 0.6037 | 0.0171 | 0.5693 | 0.6362 |
| 16 17 | 495 | 22 | 0 | 0.5768 | 0.0173 | 0.5422 | 0.6098 |
| 17 18 | 473 | 33 | 0 | 0.5366 | 0.0174 | 0.5018 | 0.57 |
| 18 19 | 440 | 32 | 0 | 0.4976 | 0.0175 | 0.4629 | 0.5312 |
| 19 20 | 408 | 28 | 0 | 0.4634 | 0.0174 | 0.4289 | 0.4971 |
| 20 21 | 380 | 30 | 0 | 0.4268 | 0.0173 | 0.3928 | 0.4604 |
| 21 22 | 350 | 26 | 0 | 0.3951 | 0.0171 | 0.3616 | 0.4284 |
| 22 23 | 324 | 33 | 0 | 0.3549 | 0.0167 | 0.3222 | 0.3876 |
| 23 24 | 291 | 33 | 0 | 0.3146 | 0.0162 | 0.2831 | 0.3466 |
| 24 25 | 258 | 19 | 5 | 0.2912 | 0.0159 | 0.2605 | 0.3226 |
| 25 26 | 234 | 24 | 1 | 0.2613 | 0.0154 | 0.2317 | 0.2918 |
| 26 27 | 209 | 28 | 3 | 0.226 | 0.0147 | 0.1979 | 0.2554 |
| 27 28 | 178 | 13 | 19 | 0.2086 | 0.0143 | 0.1813 | 0.2373 |
| 28 29 | 146 | 15 | 17 | 0.1858 | 0.0139 | 0.1594 | 0.2139 |
| 29 30 | 114 | 18 | 5 | 0.1558 | 0.0133 | 0.1308 | 0.183 |
| 30 31 | 91 | 13 | 0 | 0.1336 | 0.0128 | 0.1097 | 0.1598 |
| 31 32 | 78 | 8 | 29 | 0.1168 | 0.0125 | 0.0937 | 0.1425 |
| 32 33 | 41 | 4 | 30 | 0.0988 | 0.0134 | 0.0745 | 0.127 |
| 33 34 | 7 | 2 | 1 | 0.0684 | 0.0201 | 0.0359 | 0.115 |
| 34 35 | 4 | 0 | 4 | 0.0684 | 0.0201 | 0.0359 | 0.115 |