Online supplementary
Hospital-diagnosed sleep disorders and incident dementia: a nationwide observational cohort study

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Table S1: ICD-8 and ICD-10 diagnose codes for identification of sleep disorders

| Sleep disorder diagnosis                                      | Categories of sleep disorder type               |
|---------------------------------------------------------------|------------------------------------------------|
| Sleep apnea (ICD 10: G47.3)                                   | Sleep apnea                                    |
| Narcolepsy and cataplex (ICD 8: 347.0, ICD 10: G47.4)         | Narcolepsy and cataplex                        |
| Insomnias (ICD 10: G47.0)                                     |                                                |
| Hypersonmias (ICD 10: G47.1)                                  |                                                |
| Disorders of the sleep wake schedule (ICD 10: G47.2)          | Other specific sleep disorders                 |
| Parasomnia (ICD 10: G47.5)                                    |                                                |
| Sleep related movement disorders (ICD 10: G47.6)              |                                                |
| Non-organic sleep disorders (F51)                             |                                                |
| Other sleep disorders (ICD 10: G47.8)                         | Unspecified sleep disorders                    |
| Unspecified sleep disorder (ICD 8: 306.4, 780.6, ICD 10: G47.9) |                                                |

ICD: International classification of diseases

Table S2: ICD-8 and ICD-10 diagnose codes for identification of dementia

| Dementia type                              | ICD-8   | ICD-10                      |
|--------------------------------------------|---------|-----------------------------|
| Alzheimer's disease                        | 290.10  | F00.0-00.9, G30.0-G30.9     |
| Vascular dementia                          | 293.09-19| F01.0-01.9                   |
| Frontotemporal dementia                    | 290.11  | F02.0, G31.0A, G31.0B       |
| Dementia without specification             | 290.09, 290.19| F03.9, G31.9            |
| Other dementias                            | 290.18  | G31.8, G31.8E, F02.1-F02.8  |

ICD: International classification of Diseases
### Table S3: ATC codes for identification of pharmaceutical treatment of dementia

| Medication                  | ATC code  |
|-----------------------------|-----------|
| Donepezil                   | N06DA02   |
| Rivastigmine                | N06DA03   |
| Galantamine                 | N06DA04   |
| **Glutamate-receptor antagonists** |           |
| Memantine                   | N06DX01   |

ATC: Anatomical Therapeutic Chemical

### Table S4: ICD-8 and ICD-10 diagnostic codes for identification of comorbidities according to the Charlson Comorbidity Index (excluding dementia)

| Charlson condition                          | Weight | ICD-8                      | ICD-10                      |
|---------------------------------------------|--------|----------------------------|----------------------------|
| Myocardial infarction                       | 1      | 410                        | I21, I22, I23               |
| Congestive heart failure                    | 1      | 427.09, 427.10, 427.11, 427.19, 428.99, 782.49 | I50, I110, I130, I132       |
| Peripheral vascular disease                 | 1      | 440, 441, 442, 443, 444, 445 | I70, I71, I72, I73, I74, I77 |
| Cerebrovascular disease                     | 1      | 430-439.8                  | I60- I69, G45, G46          |
| Chronic pulmonary disease                   | 1      | 490-493, 515-518           | J40-J47, J60-J67, J684, J701, J703, J841, J920, J961, J982, J983 |
| Connective tissue disease                   | 1      | 712, 716, 734, 446, 135.99 | M05, M06, M08, M09, M30, M31, M32, M33, M34, M35, M36, D86 |
| Ulcer disease                              | 1      | 530.91, 530.98, 531-534    | K221, K25-K28               |
| Mild liver disease                         | 1      | 571, 573.01, 573.04        | B18, K700-K703, K709, K71, K73, K74, K760 |
| Diabetes mellitus                          | 2      | 249.00, 249.06, 249.07, 249.09, 250.00, 250.06, 250.07, 250.09 | E100, E101, E109, E110, E111, E119 |
| Hemiplegia                                 | 2      | 344                        | G81, G82                    |
| Moderate/severe renal disease              | 2      | 403, 404, 580-585, 590.09, 593.19, 753.10-753.19, 792 | I12, I13, N00-N05, N07, N11, N14, N17-N19, Q61 |
| Diabetes mellitus with chronic complications| 2      | 249.01-249.05, 249.08, 250.01-250.05, 250.08 | E102-E108, E112-E118 |
| Any tumor                                  | 2      | 140-194                    | C00-C75                     |
| Leukemia                                   | 2      | 204-207                    | C91-C95                     |
| Lymphoma                                   | 2      | 200-203, 275.59            | C81-C86, C88, C90, C96     |
| Moderate/severe liver disease              | 3      | 070.00, 070.02, 070.04, 070.06, 070.08, 573.00, 456.00-456.09 | B150, B160, B162, B190, K704, K72, K766, I85 |
| Metastatic solid tumor                     | 3      | 195-198, 199               | C76-C80                     |
| AIDS                                       | 6      | 079.83                     | B21-B24                    |

ICD: International classification of Diseases

### Table S5: ICD-8 and ICD-10 diagnostic codes for identification of psychiatric comorbidity

| Psychiatric condition                        | ICD-8                              | ICD-10                              |
|----------------------------------------------|-------------------------------------|-------------------------------------|
| Mood disorders                               | 296.x9 (excluding 198.89), 298.09, 298.19, 300.49, 303.19 | F30-39                              |
| Mental and behavioral disorders due to alcohol use | 291.x9, 303.x9, 303.20, 303.28, 303.90 | F10                                 |

ICD: International classification of Diseases
Table S6: IRR of dementia in individuals by type of sleep disorder and sex with 95% confidence interval (95% CI) in adjustment models 1 and 2.

| Sleep Disorder                     | Dementia cases | Person-years at risk | Rate per 1000 person-years | Adjustment model 1 | Adjustment model 2 |
|------------------------------------|----------------|----------------------|-----------------------------|--------------------|--------------------|
| ANY SLEEP DISORDER                 |                |                      |                             |                    |                    |
| Yes                                | 1,235          | 180,328              | 6.8                         | 1.43 (1.35-1.51)   | ≤.00001            |
| No (ref)                           | 74,216         | 13,899,476           | 6.3                         | 1.00               |                    |
| **Women**                          |                |                      |                             |                    |                    |
| Any sleep disorder                 | 310            | 47,107               | 6.6                         | 1.27 (1.14-1.42)   | 0.00005            |
| No sleep disorder (ref)            | 40,829         | 7,426,496            | 5.5                         | 1.00               |                    |
| **Men**                            |                |                      |                             |                    |                    |
| Any sleep disorder                 | 925            | 133,221              | 6.9                         | 1.49 (1.39-1.59)   | ≤.00001            |
| No sleep disorder (ref)            | 33,387         | 6,472,980            | 5.2                         | 1.00               |                    |
| NARCOLEPSY                         |                |                      |                             |                    |                    |
| Yes                                | 26             | 3,087                | 8.4                         | 1.47 (1.00-2.15)   | 0.06654            |
| No (ref)                           | 75,425         | 14,076,717           | 5.4                         | 1.00               |                    |
| SLEEP APNEA                        |                |                      |                             |                    |                    |
| Yes                                | 941            | 153,997              | 6.1                         | 1.32 (1.24-1.41)   | ≤.00001            |
| No (ref)                           | 74,510         | 13,925,807           | 5.4                         | 1.00               |                    |
| **Women**                          |                |                      |                             |                    |                    |
| Sleep apnea                        | 196            | 36,258               | 5.4                         | 1.10 (0.96-1.27)   | 0.17342            |
| No sleep apnea (ref)               | 40,943         | 7,437,345            | 5.5                         | 1.00               |                    |
| **Men**                            |                |                      |                             |                    |                    |
| Sleep apnea                        | 745            | 117,740              | 6.3                         | 1.38 (1.28-1.49)   | ≤.00001            |
| No sleep apnea (ref)               | 33,567         | 6,488,462            | 5.2                         | 1.00               |                    |
| OTHER SPECIFIC DISORDERS           |                |                      |                             |                    |                    |
| Yes                                | 247            | 19,223               | 12.8                        | 2.40 (2.12-2.72)   | ≤.00001            |
| No (ref)                           | 75,204         | 14,062,985           | 5.4                         | 1.00               |                    |
| **Women**                          |                |                      |                             |                    |                    |
| Other specific disorder            | 80             | 6,957                | 11.5                        | 2.07 (1.66-2.58)   | ≤.00001            |
| No other specific disorder (ref)   | 41,059         | 7,466,646            | 5.5                         | 1.00               |                    |
| **Men**                            |                |                      |                             |                    |                    |
| Other specific disorder            | 167            | 12,266               | 13.6                        | 2.59 (2.22-3.01)   | ≤.00001            |
| No other specific disorder (ref)   | 34,145         | 6,593,935            | 5.2                         | 1.00               |                    |
| UNSPECIFIED SLEEP DISORDER         |                |                      |                             |                    |                    |
| Yes                                | 154            | 16,819               | 9.2                         | 1.53 (1.31-1.79)   | ≤.00001            |
| No (ref)                           | 75,297         | 14,062,985           | 5.4                         | 1.00               |                    |
|       | Dementia cases | Person-years at risk | Rate per 1000 person-years | Adjustment model 1 | Adjustment model 2 |
|-------|----------------|----------------------|-----------------------------|-------------------|-------------------|
|       |                |                      | IRR (95% CI) | P value | IRR (95% CI) | P value |
| **Women** |                |                      |               |         |               |         |
| Unspecified sleep disorder | 46  | 5,526              | 8.3          | 1.33 (0.99-1.77) | 0.06598 | 1.09 (0.82-1.46) | 0.54976 |
| No unspecified sleep disorder (ref) | 41,093 | 7,468,077       | 5.5          | 1.00    |               |         |
| **Men** |                |                      |               |         |               |         |
| Unspecified sleep disorder | 108 | 11,293            | 9.6          | 1.64 (1.36-1.98) | ≤.00001 | 1.38 (1.14-1.66) | 0.00159 |
| No unspecified sleep disorder (ref) | 34,204 | 6,594,908      | 5.2          | 1.00    |               |         |

Abbreviations: IRR: incidence rate ratios, CI: confidence interval, ref: reference group.
Model 1 was adjusted for age, sex and calendar year. Model 2 was further adjusted for highest attained educational level at age 50 and somatic comorbidity using the Charlson Comorbidity Index.
Table S7: IRR of dementia in individuals by type of sleep disorder and age with 95% confidence interval (95% CI) in adjustment models 1 and 2.

|                                | Dementia cases | Person-years at risk | Rate per 1000 person-years | Adjustment model 1 | Adjustment model 2 |
|-------------------------------|----------------|----------------------|-----------------------------|--------------------|--------------------|
| **ANY SLEEP DISORDER**        |                |                      |                             |                    |                    |
| Any sleep disorder age 50-64 years | 400            | 100,866              | 4.0                         | 1.30 (1.18-1.43)   | ≤.00001            |
| No sleep disorder age 50-64 years (ref) | 75,051        | 13,978,938           | 5.4                         | 1.00               | 1.00               |
| Any sleep disorder age ≥65 years | 948            | 98,885               | 9.6                         | 1.48 (1.39-1.58)   | ≤.00001            |
| No sleep disorder age ≥65 years (ref) | 74,503        | 13,980,920           | 5.3                         | 1.00               | 1.00               |
| **SLEEP APNEA**               |                |                      |                             |                    |                    |
| Sleep apnea age 50-64 years   | 309            | 86,011               | 3.6                         | 1.25 (1.12-1.40)   | 0.00019            |
| No sleep apnea age 50-64 years (ref) | 75,142        | 13,993,793           | 5.4                         | 1.00               | 1.00               |
| Sleep apnea age ≥65 years     | 727            | 85,702               | 8.5                         | 1.35 (1.25-1.45)   | ≤.00001            |
| No sleep apnea age ≥65 years (ref) | 74,724        | 13,994,103           | 5.3                         | 1.00               | 1.00               |
| **OTHER SPECIFIC DISORDERS**  |                |                      |                             |                    |                    |
| Other specific disorder age 50-64 years | 56            | 10,180               | 5.5                         | 1.72 (1.32-2.24)   | 0.00020            |
| No other specific disorder age 50-64 years (ref) | 75,395        | 14,069,625           | 5.4                         | 1.00               | 1.00               |
| Other specific disorder age ≥65 years | 191           | 9,280                | 20.6                        | 2.66 (2.31-3.06)   | ≤.00001            |
| No other specific disorder age ≥65 years (ref) | 75,260        | 14,070,525           | 5.3                         | 1.00               | 1.00               |
| **UNSPECIFIED SLEEP DISORDER**|                |                      |                             |                    |                    |
| Unspecified sleep disorder age 50-64 years | 63            | 9,213                | 6.8                         | 1.43 (1.12-1.83)   | 0.00752            |
| No unspecified sleep disorder age 50-64 years (ref) | 75,388        | 14,070,592           | 5.4                         | 1.00               | 1.00               |
| Unspecified sleep disorder age ≥65 years | 91            | 7,718                | 11.8                        | 1.60 (1.30-1.96)   | 0.00004            |
| No unspecified sleep disorder age ≥65 years (ref) | 75,360        | 14,072,087           | 5.4                         | 1.00               | 1.00               |

Abbreviations: IRR: incidence rate ratios, CI: confidence interval, ref: reference group.
Model 1 was adjusted for age, sex and calendar year. Model 2 was further adjusted for highest attained educational level at age 50 and somatic comorbidity using the Charlson Comorbidity Index.
Table S8: Post-hoc analysis. Incidence rate ratio (IRR) of dementia in individuals with other specific sleep disorders with 95% confidence interval (95% CI).

| Group                                      | Dementia cases | Person-years at risk | Rate per 1000 person-years | Adjustment model 1 | Adjustment model 2 |
|--------------------------------------------|----------------|----------------------|----------------------------|--------------------|--------------------|
|                                            |                |                      |                            | IRR (95% CI)       | P value            |
|                                            |                |                      |                            | P value            |                    |
| Excluding Insomnias                        |                |                      |                            |                    |                    |
| Other specific sleep disorders             | 233            | 17,420               | 13.4                       | 2.49 (2.19-2.84)   | ≤.00001            |
|                                            |                |                      |                             | 1.86 (1.64-2.12)   | ≤.00001            |
| No sleep disorder (ref)                    | 75,218         | 14,062,384           | 5.3                        | 1.00               | 1.00               |
| Excluding hypersomnias                     |                |                      |                            |                    |                    |
| Other specific sleep disorders             | 205            | 12,782               | 16.0                       | 2.82 (2.46-3.24)   | ≤.00001            |
|                                            |                |                      |                             | 1.97 (1.71-2.25)   | ≤.00001            |
| No sleep disorder (ref)                    | 75,246         | 14,067,023           | 5.3                        | 1.00               | 1.00               |
| Excluding disorders of the sleep wake schedule |           |                      |                            |                    |                    |
| Other specific sleep disorders             | 231            | 17,490               | 13.2                       | 2.46 (2.16-2.80)   | ≤.00001            |
|                                            |                |                      |                             | 1.84 (1.62-2.09)   | ≤.00001            |
| No sleep disorder (ref)                    | 75,220         | 14,062,314           | 5.3                        | 1.00               | 1.00               |
| Excluding parasomnia                       |                |                      |                            |                    |                    |
| Other specific sleep disorders             | 179            | 17,946               | 10.0                       | 1.88 (1.63-2.18)   | ≤.00001            |
|                                            |                |                      |                             | 1.40 (1.21-1.62)   | 0.00002            |
| No sleep disorder (ref)                    | 75,272         | 14,061,859           | 5.4                        | 1.00               | 1.00               |
| Excluding non-organic sleep disorders      |                |                      |                            |                    |                    |
| Other specific sleep disorders             | 209            | 15,522               | 13.5                       | 2.55 (2.22-2.92)   | ≤.00001            |
|                                            |                |                      |                             | 1.87 (1.63-2.14)   | ≤.00001            |
| No sleep disorder (ref)                    | 75,242         | 14,064,282           | 5.3                        | 1.00               | 1.00               |
| Parasomnia                                 |                |                      |                            |                    |                    |
| Other specific sleep disorders             | 193            | 16,035               | 12.0                       | 2.31 (2.00-2.66)   | ≤.00001            |
|                                            |                |                      |                             | 1.89 (1.64-2.18)   | ≤.00001            |
| No sleep disorder (ref)                    | 75,258         | 14,063,770           | 5.4                        | 1.00               | 1.00               |

IRRs are presented for the sleep disorder category other specific disorders excluding one diagnosis at a time from the exposure group. The reference group is individuals without the remaining other specific sleep disorders. Abbreviations: IRR: incidence rate ratios, CI: confidence interval, ref: reference group.

Model 1 was adjusted for age, sex and calendar year. Model 2 was further adjusted for highest attained educational level at age 50 and somatic comorbidity using the Charlson Comorbidity Index. Model 3 was further adjusted for psychiatric comorbidity.
### Table S9: Time between any sleep disorder diagnosis and dementia diagnosis. Incidence rate ratio (IRR) with 95% confidence interval (95% CI), in adjustment models 1 and 2.

|                        | Adjustment model 1 |                      | Adjustment model 2 |                      |
|------------------------|--------------------|----------------------|--------------------|----------------------|
|                        | IRR (95% CI)       | P value              | IRR (95% CI)       | P value              |
| Within 5 years         | 1.73 (1.60-1.88)   | ≤.00001              | 1.50 (1.38-1.63)   | ≤.00001              |
| After 5 years          | 1.23 (1.14-1.33)   | ≤.00001              | 1.12 (1.04-1.21)   | 0.00456              |
| No sleep disorder      | 1.00               |                      | 1.00               |                      |

IRRs are presented for by time between sleep disorder diagnosis and dementia diagnosis. The reference group is individuals without any sleep disorder. Abbreviations: IRR, incidence rate ratios, CI, confidence interval, ref, reference group.

Model 1 was adjusted for age, sex and calendar year. Model 2 was further adjusted for highest attained educational level at age 50 and somatic comorbidity using the Charlson Comorbidity Index.