





BMJ Open Elevated prevalence and treatment of sleep disorders from 2011 to 2020: a nationwide population-based retrospective cohort study in Korea

Eunkyong Ahn , Younghwa Baek , Ji-Eun Park, Siwoo Lee ,
Hee-Jeong Jin 

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ABSTRACT

Objectives This study used National Health Insurance claims data from Korea to report the prevalence of sleep disorders and treatment status, including traditional Korean medicine, in the last 10 years.

Methods This is a retrospective cohort study in Korea. All diagnosis and prescription data, including herbal medicine claims, from the Health Insurance Review and Assessment Service from 2011 to 2020 were reviewed. Prevalence estimation, direct medical expenses and prescribed amounts for sleep disorders were recorded.

Results The prevalence of sleep disorders increased from 3 867 975 (7.62%) in 2011 to 7 446 846 (14.41%) in 2020, nearly doubling over 10 years. Insomnia was observed in 91.44% (n=9 011 692) of the patients. The mean number of hospital visits per patient for sleep disorders was 11.5 (± 26.62). Benzodiazepines are the most commonly prescribed medications for sleep disorders, and gamma-isoyoson is the most frequently prescribed herbal medicine.

Conclusions Sleep disorders are continuously increasing, as is the use of medical services—personal and social medical expenses are also increasing accordingly. Sleep disorders should be recognised as a significant health problem that needs to be actively addressed to improve quality of life.

INTRODUCTION

Sleep disorders are highly related to chronic pain, cardiovascular disease, dementia, metabolic syndrome and digestive dysfunction,^{1–4} reportedly increasing the risk of death and deteriorating the quality of life and overall health condition, resulting in an economic burden on the patient and his family.^{5 6} Occupational noise exposure and the increased use of smartphones have been found to induce sleep disorders.^{7 8} It is estimated that short-term insomnia impacts 30–50% of the population.⁹ The prevalence of sleep disorders in the USA was 20–41.7% in 2011,¹⁰ and from 2013 to 2016, the prevalence has increased by approximately 40%.¹¹ The prevalence of insomnia is at least 6% in

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is a nationwide health insurance claims data for the prevalence and status of treatment on sleep disorders for 10 years.
- ⇒ This study will be meaningful because we have confirmed the current address of the prevalence and treatment of sleep disorders in the last 10 years.
- ⇒ The data source has the limitation of being able to confirm only the items subject to health insurance benefits and review.
- ⇒ The results of tests for the diagnosis of sleep disorders were not confirmed.

developed countries,¹² 10% in Norway and England,^{13 14} 5.7% in Germany¹⁵ and 19% in France.¹⁶ In the case of Asia, Japan recorded 13.5% of insomnia cases in 2016.¹⁷ In a 2002 study examining the prevalence of insomnia in South Korea, it was reported that 17% of the participants experienced symptoms of insomnia three or more times per week. Similarly, a study based on the 2009 Korean Census revealed that more than one-fifth (22.8%) of the 5000 participants had experienced insomnia.^{18 19} In the same 2002 study, the authors further reported that 5% of insomnia cases met the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (American Psychiatric Association) diagnostic criteria.¹⁸ Moreover, in situations of heightened personal and social stress, such as the COVID-19 pandemic, the worldwide prevalence of sleep disorders surged to approximately 40%.²⁰ Sleep disorders are becoming a common concern in our society; it is considered that the scale of physical, mental, economic and social damage is very likely to increase in the long term. Sleep disorders may appear and disappear temporarily but often persist chronically. Reports on the nature of insomnia have revealed that approximately 46% of patients have experienced persistent



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Korean Medicine Data Division, Korea Institute of Oriental Medicine, Yuseong-gu, Daejeon, Korea (the Republic of)

Correspondence to

Dr Hee-Jeong Jin;
hjjin@kiom.re.kr

symptoms for 3 years,²¹ while other studies have shown that approximately 45% of patients continuously experience insomnia after its onset.^{22 23}

Both non-pharmacological and pharmacological treatment strategies are available to treat sleep disorders. According to clinical practice guidelines for insomnia, pharmacological therapy is provided if the patient fails to respond to cognitive-behavioural therapy (CBT) or if treatment is not feasible in Korea. Importantly, specific medications are prescribed for sleep initiation or maintenance disorders.^{24–26} The European Sleep Research Society treatment guidelines for sleep disorders recommend that benzodiazepines and z-drugs should not be used for long-term therapy.²⁵ Moreover, the American College of Physicians treatment guidelines recommend using these drugs for a short period (4–5 weeks) only, as approved by the US Food and Drug Administration (FDA).²⁴ Chronic use of sleeping pills has been shown to increase the risk of side effects such as daytime sleepiness, ataxia, dizziness, cognitive decline, increased aggressive behaviour, delirium, worsening of apnoea and increased risk of dementia.^{27–30} In Korea and China, patients could opt for sleep disorder treatments such as acupuncture or herbal medicine as alternatives to initial treatment or long-term medication. According to the Clinical Practice Guideline of Korean medicine for insomnia disorders, treatment for insomnia is divided into herbal medicine, acupuncture and non-acupuncture herbal medicine treatment³¹ depending on the symptoms, with the use of acupuncture and herbal medicine alone or in combination. Currently, definitive treatment for sleep disorders is lacking, and their growing prevalence necessitates long-term management strategies. Moreover, although sleep disorders may not be directly fatal, they can substantially impact quality of life, disease prognosis and overall mortality rates. Therefore, understanding the current prevalence and treatment modalities is of paramount importance.

In the Republic of Korea, the National Health Insurance System serves as a comprehensive social insurance programme. Following the conclusion of the 2022 fiscal year, the system boasts an enrolment exceeding 52 million individuals, thereby encompassing the vast majority of the nation's populace. The Health Insurance Review and Assessment Service (HIRA) maintains a robust database that not only archives beneficiary-specific information but also provides granular details pertaining to medical services, including diagnostic codes, procedural interventions, pharmaceutical prescriptions, and the categorisation of healthcare institutions and departments. Both HIRA and the National Health Insurance Corporation facilitate research endeavours by offering services that de-identify and expunge personally identifiable information from these medical utilisation records.

The objective of this study is to present the current status of the prevalence of sleep disorders and various treatment approaches in South Korea. The specific goals are as follows: first, to report the prevalence of sleep

disorders during the period from 2011 to 2020. Second, to provide an overview of the status of medication and therapeutic prescriptions.

METHODS

Data source and study population

In the current study, we used customised research data (no. M20210819448) from the Healthcare Big Data Hub platform of HIRA. The data were provided after review by the Public Data Provision Deliberation Committee of HIRA. In HIRA, the research data include treatment information for the entire population of South Korea. HIRA provides extracted, summarised and anonymised health insurance claim data that have been collected, maintained and managed to promote academic research. The data included all patients diagnosed with sleep disorders as a primary or secondary diagnosis between 1 January 2011 and 31 December 2020. Medical records containing information on sleep disorder diagnoses were extracted based on the diagnosis code registered by the treating doctor. Individuals diagnosed with sleep disorders at least once during the observation period and prescribed medication were enrolled in this study. Subjects were included regardless of age; however, veterans were excluded from the study.

Sleep disorders

The Korean Standard Classification of Diseases version 7 (KCD-7) was used to identify subjects with sleep disorders. The KCD-7 code is based on the International Classification of Diseases version 10 code system and reflects the unique disease characteristics of Korea. The subdivision classification for frequent diseases, reorganisation of the Korean medicine classification and diagnostic codes for rare diseases are also reflected. Sleep disorders were classified according to the criteria of the third edition of the International Classification of Sleep Disorders (ICSD-3)²⁶: insomnia, sleep-related breathing disorders, sleep-related movement disorders, circadian rhythm sleep-wake disorders, central disorders of hypersomnolence, parasomnia and other unspecified sleep disorders. The sleep disorder classification, KCD-7 and detailed diagnoses are provided in online supplemental table 1.

Medications for sleep disorders

Drugs approved by the Korea FDA (KFDA) for insomnia are classified into benzodiazepines, non-benzodiazepines, antidepressants, antihistamines and antipsychotics. In Korea, a dual medical service system allows for both Western and Korean medical treatments to be prescribed, including herbal medicines. This study specifically focuses on herbal medicines that are covered by the National Health Insurance Service. Furthermore, these herbal medicines can only be obtained through a prescription from a licensed Korean medicine doctor. Online supplemental table 2 provides a list of the licensed drugs indicated for sleep disorders, including herbal medicines. In the

present study, all 56 types of herbal medicines reimbursed (online supplemental table 3) and subject to review by HIRA were reviewed. Herbal medicines for sleep disorder indications included Gamisoyo-san, Hwanglyeonhaedok-tang, Galgeunhaegui-tang, Dangguiyukhwang-tang and Soshiho-tang.

Covariables

Criteria for calculating covariates vary depending on the nature of each variable. Specifically, the prevalence of sleep disorders was determined based on the number of diagnosed individuals, while the frequency of medical visits was assessed using healthcare claims. Medication prescriptions were calculated based on the number of entries in healthcare claims. Quantitative variables such as age, the number of medical visits per individual and incurred medical costs are reported as mean values with SDs. Categorical variables, including the type of hospital visited, whether the treatment was inpatient or outpatient, subtypes of sleep disorders, gender and individual prescription status, are presented as counts and percentages. All medical expenses were denominated in South Korean won (KRW).

Data preprocessing and statistical analysis

Data were analysed using a remote analysis system provided by the Healthcare Big Data Hub, accessible only from pre-authorised, researcher-approved personal computers (PCs). To calculate the yearly prevalence of sleep disorders, individual subjects who were diagnosed and prescribed medications were counted. The total population for each year was determined based on data provided by the Ministry of Public Administration and Security's Annual Statistical Yearbook Population.²⁴ To analyse differences between groups, X^2 tests were employed, and results were considered statistically significant at a level of $p < 0.05$. Descriptive statistics were used to calculate yearly prevalence rates. All statistical analyses were conducted using the Statistical Analysis System (SAS) Enterprise Guide V.9.4.2 (SAS Institute), installed on a virtualised PC.

RESULTS

General information

In the decade spanning from 2011 to 2020, a total of 7 467 730 individuals sought medical care to address sleep disorders. Females constituted the majority, representing 59.62% ($n = 4\,452\,628$) of this cohort. The mean age across the entire study population was 53.47 ± 17.95 years, with males presenting a slightly younger mean age (52.31 ± 18.18 years) than females (54.26 ± 17.74 years). Age distribution analysis, segmented into decadal intervals, revealed an ascending trend in the prevalence of sleep disorders with advancing age, reaching a zenith in the 50–60 age group, followed by a subsequent decline. The categorisation of sleep disorders, as per the ICSD-3, indicated a higher prevalence of insomnia among

female patients, accounting for 60.3% of cases. Insomnia emerged as the predominant sleep disorder diagnosis, with 93.7% ($n = 6\,995\,674$) of patients presenting with this condition, thereby representing the most prevalent reason for availing medical treatment. The second most common diagnostic category was 'other unspecified sleep disorders', encompassing 4.6% ($n = 342\,213$) of the patient population. The remainder of sleep disorder diagnoses collectively constituted less than 2% of the overall patient distribution, as detailed in table 1.

Annual prevalence/incidence of sleep disorders and use of medical services

The annual prevalence of sleep disorders in patients aged >10 years increased from 3 867 975 (7.6%, 76.2 per 1000 person-years) in 2011 to 7 446 846 (14.4%, 144.1 per 1000 person-years) in 2020, nearly doubling in 10 years. The number of male patients increased from 1 477 614 (5.8%, 58.2 per 1000 person-years) to 2 987 309 (11.6%, 115.6 per 1000 person-years), and the number of female patients increased from 2 390 361 (9.4%, 94.42 per 1000 person-years) to 4 459 537 (17.3%, 172.72 per 1000 person-years), with similar increase rates observed among both sexes (figure 1 and online supplemental table 4). On examining the annual number of new patients with sleep disorders, an additional 665 325 individuals were diagnosed in 2012, comprising 60.3% of female patients. Subsequently, the incidence of sleep disorders decreased to 225 753 new patients in 2017, followed by a resurgence in numbers starting in 2018 (figure 2). The mean number of visits to the hospital for sleep disorder diagnosis for the past 10 years was 11.55 ± 26.62 , and females visited the hospital (11.96 ± 27.43) more often than males (10.94 ± 25.37). The total hospital visits also increased from 5 932 505 in 2011 to 11 111 518 by 2020. Hospital visits increased from 37.1% to 39.1% in males and decreased from 62.9% to 60.9% among females. Accordingly, we noted an increased proportion of females among the total number of patients and an increased number of hospital visits among males (online supplemental figure 1). Treatment with Korean medications accounted for approximately 9.6% ($N = 8\,323\,747$) of the total hospital visits for sleep disorders. Overall, a higher proportion of females (11.4%; $n = 6\,066\,211$) than that of males (6.8%, $n = 2\,257\,536$) visited a Korean medical institute. The mean number of hospital visits per patient was 11.7 ± 27.4 (SD) for females and 10.9 ± 25.4 for males. The mean cost of total medical expenses per visit was 71 931 KRW, and the mean cost per patient was 830 707 KRW (table 2).

Medication prescriptions and others

Over the past decade, medications covered by the National Health Insurance for sleep disorders in Korea included 59 811 619 (49.5%) prescriptions for benzodiazepines, 33 730 406 (27.9%) prescriptions for non-benzodiazepines and 19 627 973 (16.2%) prescriptions for antidepressants. On examining the overall distribution of medication prescriptions, 49.5% of the prescribed drugs were

Table 1 Basic characteristics of study population

	Total	Men	Women
N*	7 467 730	3 015 102 (40.3%)	4 452 628 (59.62%)
Age	53.5±18.0	52.3±18.2	54.3±17.7
Age group			
≤10	73 056 (1.0%)	41 865 (1.4%)	31 191 (0.7%)
<10–20	199 552 (2.7%)	95 179 (3.2%)	104 373 (2.3%)
<20–30	630 869 (8.4%)	268 313 (8.9%)	362 556 (8.1%)
<30–40	885 756 (11.9%)	389 187 (12.9%)	496 569 (11.2%)
<40–50	1 288 480 (17.3%)	526 319 (17.5%)	762 161 (17.1%)
<50–60	1 644 936 (22.0%)	626 554 (20.8%)	1 018 382 (22.9%)
<60–70	1 319 966 (17.7%)	533 208 (17.7%)	786 758 (17.7%)
<70	1 425 115 (19.1%)	534 477 (17.7%)	890 638 (20.0%)
Type of sleep disorders*			
Insomnia	6 995 674	2 776 593 (39.7%)	4 219 082 (60.3%)
Unspecified sleep disorders	342 213	185 895 (54.3%)	156 318 (45.7%)
Other sleep disorders	129 843	52 615 (40.5%)	77 228 (59.5%)

Data are represented as number and proportion (%) or mean±SD.

*Proportion was calculated using rows.

from the benzodiazepine class, 27.9% from the non-benzodiazepines, 16.2% were antidepressants and ~6.3% were antipsychotics. Assessing the distribution of medication prescriptions according to the type of sleep disorder, patients diagnosed with ‘unspecified sleep disorders’ had the highest proportion of benzodiazepine prescriptions (62.3%). In contrast, patients diagnosed with ‘insomnia’ had the lowest benzodiazepine prescription rate (47.8%) and predominantly received non-benzodiazepine prescriptions (29.3%). Patients diagnosed with ‘sleep-related breathing disorders’ had a higher antidepressant prescription rate (21.3%) than those with other diagnoses (figure 3). According to the National Health Insurance, herbal medicines prescribed for sleep disorders included 100 065 cases of Gamisoyo-san, 23 841 cases of Hwanglyeonhaedok-tang and 11 490 cases of Soshiho-tang (figure 3). Excluding herbal medicines, acupuncture was the most frequently prescribed treatment (13

727 099 cases), followed by moxibustion, hot/cold physical therapy, electronic needle stimulation and cupping (online supplemental figure 2).

DISCUSSION

The prevalence of sleep disorders in Korea has nearly doubled over the past 10 years, from 9.4% in 2011 to 17.3% in 2020. Similarly, the prevalence of sleep disorders in countries like the USA, Norway, England, Germany and Japan has shown an overall increasing trend.^{9 11 13 15 17 19} Several possible explanations could clarify this recent increase in the prevalence of sleep disorders. First, it can be assumed that primary or secondary sleep disorders will increase in absolute numbers, and secondary sleep disorders, such as insomnia, are caused by the use of drugs and substances or by medical or psychiatric diseases, accounting for more than 70% of all insomnia.³² Moreover, the prevalence of

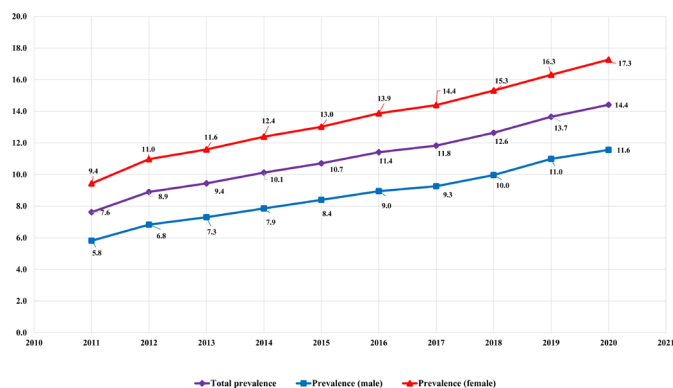


Figure 1 Annual prevalence of sleep disorders for 10 years by sex (2011–2020).

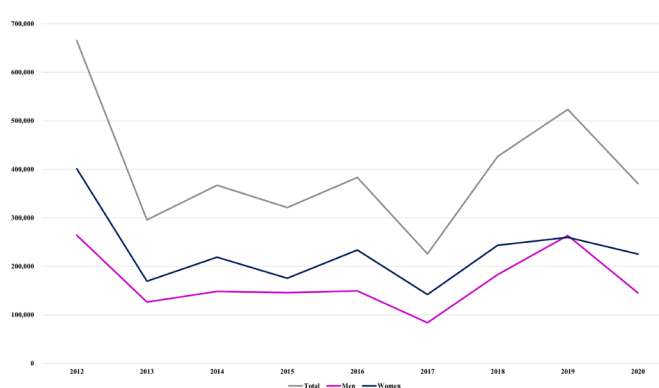


Figure 2 Annual incidence of sleep disorders for 10 years by sex (2012–2020).

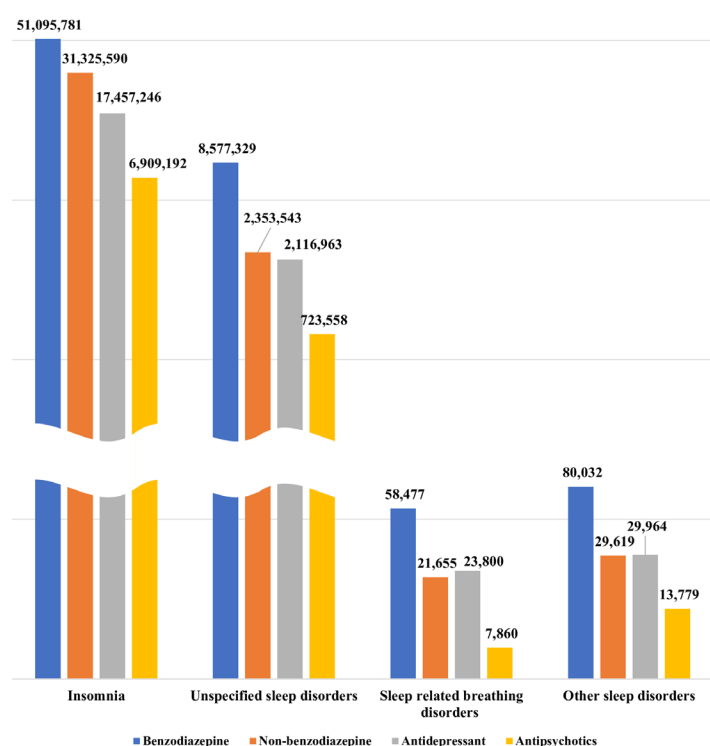
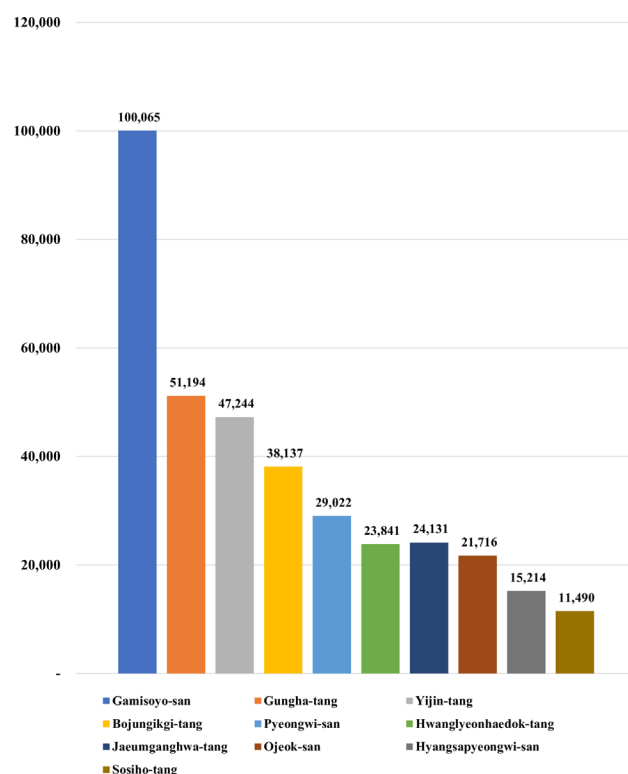
Table 2 Use of medical services by sex

Variables	Total	Male	Female	P value
Total number of medical visits	86 242 369	32 983 344	53 259 025	
Number of medical visits per patient	11.5 (\pm 26.6)	10.9 (\pm 25.4)	11.7 (\pm 27.4)	<0.0001
Type of medical service				
Korean medicine	8 323 747 (9.7%)	2 257 536 (6.8%)	6 066 211 (11.4%)	<0.0001
Western medicine	77 918 622 (90.3%)	30 725 808 (93.2%)	47 192 814 (88.6%)	
Type of medical visit				
Inpatient admission	2 488 588 (2.9%)	1 478 311 (4.5%)	1 010 277 (1.9%)	<0.0001
Outpatient visit	83 753 781 (97.1%)	31 505 033 (95.5%)	52 248 748 (98.1%)	
Medical expenses per visit				
Total medical expenses	71 931 (\pm 372 377)	91 654 (\pm 453 808)	59 716 (\pm 310 819)	<0.0001
Patient charge	12 785 (\pm 56 287)	14 697 (\pm 63 616)	11 601 (\pm 51 188)	<0.0001
Drug prescription fee	11 629 (\pm 161 062)	12 651 (\pm 244 311)	10 996 (\pm 71 006)	<0.0001
Medical expenses per patient				
Total medical expenses	830 707 (\pm 4 595 063)	1 002 640 (\pm 5 476 533)	714 282 (\pm 3 881 934)	<0.0001
Patient charge	147 655 (714 887)	160 782 (\pm 792 815)	138 765 (\pm 138 765)	<0.0001
Medication prescription fee	134 300 (\pm 929 518)	138 394 (\pm 1 107 515)	131 528 (\pm 786 423)	<0.0001

Data are represented as number and proportion (%) or mean \pm SD.

secondary sleep disorders increases with the prevalence of cancer, Parkinson's disease and degenerative cerebrovascular diseases such as dementia and obesity, which are well-known causes of sleep disorders.^{33–35} Furthermore, since 2020, the number of individuals with sleep disorders has increased worldwide, which could be the aftermath

of the COVID-19 pandemic.³⁶ Second, the growing prevalence could be attributed to behavioural changes in seeking medical services to resolve the problems, owing to changes in the patient's perceptions of sleep disorders. Previously, sleep disorders, such as insomnia, were considered secondary symptoms resulting from diseases rather

**Figure 3** Medication prescriptions for sleep disorders by medical type.

than as an individual disease. However, with the revision of ICSD-2 to ICSD-3, insomnia was suggested as a separate disorder.²⁶ Accordingly, there has been an apparent change in the recognition of insomnia as a disease requiring treatment, such as paying attention to classification according to objective sleep duration in clinical practice and applying it to treating insomnia cases.³⁷ In 2017, the American Academy of Sleep Medicine and the European Academy of Sleep Medicine published guidelines for insomnia treatment that preferentially recommend CBT.^{26 38}

Hospital visits owing to sleep disorders were more frequent among females than among males. Previous studies have shown sex differences in the prevalence and types of sleep disorders. A meta-analysis of sex differences in the prevalence of insomnia has found a markedly higher prevalence among females.³⁹ The high prevalence of sleep disorders among females, including insomnia, is multifactorial and could be due to the greater likelihood of females experiencing physical problems such as osteoporosis, fractures and joint diseases, which affect sleep quality. Moreover, it is well established that females have a higher risk of developing psychiatric problems such as depression and anxiety than males, thereby resulting in increased insomnia risk.⁴⁰ According to the results of the current study, insomnia accounts for more than 90% of all sleep disorders. Hence, the above factors can explain the higher prevalence of sleep disorders among females. Conversely, in the case of obstructive sleep apnoea (OSA), the proportion of all sleep disorders remains low and hence does not substantially affect the overall prevalence; however, it is well-known that the OSA prevalence is higher in males than that in females.^{41 42}

The current study confirmed that the average age for sleep disorder diagnosis in Korea is 53.5 years old and that the number of patients with sleep disorders tends to increase. A considerable number of older patients experience sleep disorders because sleep quality decreases with age owing to the apparent evolutionary biological relationship between ageing and sleep. Several sleep-related studies have reported that subjective and objective sleep quality deteriorates with age.^{43 44} Comparing sleep between older and younger adults, older adults spend less time in slow-wave sleep, resulting in a reduced percentage of deep sleep.⁴⁵ As individuals age, sleep becomes more fragmented, resulting in changes in sleep stages and more frequent awakenings.⁴⁶ Moreover, sleep homeostasis decreases with age.⁴⁷ Furthermore, it is well-known that the prevalence of diseases that induce sleep disorders, such as metabolic disorders, cardiovascular diseases, neurodegenerative diseases and cancer, increases with age.^{48–52}

Comparing the results of the current study with previous research on insomnia in Korea, it is evident that the prevalence and incidence of insomnia are continuously increasing. According to the ICSD-3, insomnia is the most common type of sleep disorder. Our study indicates that approximately 17.5% of Koreans visit hospitals for

insomnia, which has increased from the 17% reported in 2002 and decreased from the 22.8% in 2009.^{18 19} Additionally, another study spanning from 2005 to 2013 reported that 5.78% of adults aged ≥ 20 years were suffering from insomnia.⁵³ Insomnia is defined as ‘a persistent difficulty with sleep initiation, duration, consolidation or quality that occurs despite adequate opportunity and circumstances for sleep and results in some form of daytime impairment’.⁵⁴ This definition underscores that insomnia is more than just a lack of sleep; it is a serious health concern that can impact daily life. Compared with international reports, the growing trend of insomnia in Korea appears to be consistent with patterns observed in other countries, suggesting that insomnia is emerging as a substantial public health issue worldwide. This increasing trend in insomnia could be attributed to socioeconomic stress, lifestyle changes and an ageing population. In this context, the findings of our study enhance the current understanding regarding the prevalence and incidence of insomnia in Korea and provide essential baseline data for developing future prevention and treatment strategies. Moreover, considering the rising trend of insomnia, there is an urgent need to establish more effective responses to this condition.

Over the past 10 years, the mean number of hospital visits owing to sleep disorders in Korea was 11.5, and the mean total medical expense for a single patient during the observation period was 830 707 KRW (US\$629.13). The insomnia-related examination cost \$3 508 635, which was approximately half of total insomnia-related medical expenses.⁵⁵ Australia has reported total direct health expenditures related to inadequate sleep of approximately \$A1.24 billion from 2016 to 2017.⁵⁶ In the USA, the direct medical cost due to insomnia in 1995 was estimated at approximately \$13.9 billion,⁵⁷ and in a review paper on the health economics of insomnia treatment published in 2016, the costs for insomnia treatment were found to exceed \$100 billion per year.⁵⁸ In the USA, direct/indirect social costs owing to insomnia increased by approximately 10 times over nearly 20 years, predominantly contributing to indirect costs such as decreased work performance, increased use of medical care and increased risk of accidents.⁵⁸ The social cost to be paid due to sleep disorders is growing at a non-negligible rate over time, and improving sleep quality is a social task that needs to be resolved urgently.

Notably, CBT is initially recommended according to the Korean Neuropsychiatric Association guidelines for insomnia treatment.⁵⁹ However, it was not until 2018 that CBT was recognised as a reimbursable item under the National Health Insurance in Korea. Therefore, CBT treatments prior to 2018 are excluded from the health insurance reimbursement data. Accordingly, the current study faces limitations in reporting the status of sleep disorder treatments over the past decade, including CBT, owing to the following reasons: the implementation of the system only began in 2018, with the initial establishment of practice occurring gradually. Consequently, this study

does not report data on CBT, which is recommended as an initial treatment. Moreover, given the time and effort required to implement CBT, clinicians often prescribe sleep medications as a first-line treatment, which is more frequently observed in clinical settings.⁵⁹ In the current study, benzodiazepines and non-benzodiazepines accounted for 47.8% and 29.3% of prescription drugs for sleep disorders, respectively. Although sleeping pills are an effective and easy method for treating insomnia, they carry the risk of dependence and abuse. The KFDA and treatment guidelines recommend shortening drug treatment for unremedied insomnia, mostly within 4 weeks. In Korea, approximately 10% of patients were prescribed herbal medicine for treating sleep disorders. In practice, Western medicine and Korean herbal medicines are prescribed separately or in combination to treat sleep disorders. However, studies assessing the effects or side effects of combined prescription of therapeutic agents with herbal medicines in patients with sleep disorders are lacking.

Here, we highlight the following strengths and limitations of our study. The most notable strength of our research lies in the data source used for analysis, which permitted the estimation of sleep disorder diagnoses and medical utilisation behaviours among the entire population. This study boasts the largest sample size available in Korea, the ability to verify data continuously over an extended period and the inclusion of physician-diagnosed patients with sleep disorders. Additionally, our data documented the status of sleep disorders over the past decade. Despite these strengths, our study also includes unavoidable limitations. First, the nature of the data source, generated for the purpose of medical insurance claims, presents a drawback. It fails to provide information regarding medical interventions or tests unrelated to insurance benefits. Particularly, as previously mentioned, items, such as the status of CBT, cannot be uniformly reported owing to the application period of the medical benefit system. Furthermore, information on 'herbal decoctions', which are widely prescribed in real-world settings but not included in the benefits system, may be omitted. Sleep disorders can manifest in various ways, either occurring independently or in conjunction with comorbid conditions. However, our study primarily focused on investigating the prevalence of sleep disorders and the diversity of treatment methods in Korea. Consequently, we were unable to analyse other variables related to psychiatric comorbid conditions, which require prior review and approval for study inclusion. Future research is needed to explore comorbid conditions accompanying sleep problems. Nevertheless, the current study has endeavoured to objectively report on sleep disorder-related information over the past decade based on health insurance review data. We anticipate that future research, incorporating linked data, patient self-survey results, subjective evaluations of diseases and treatments, and information regarding non-insurance-covered treatments, will enable more comprehensive and valuable investigations.

In conclusion, our research reveals a noteworthy twofold increase in the prevalence of sleep disorders in Korea from 9.4% in 2011 to 17.3% in 2020, mirroring a global trend that signals a significant and expanding public health issue. Particularly, insomnia stands out as the predominant sleep disorder, impacting more than 90% of cases, with a heightened prevalence among females. The escalating burden is evident through a rise in hospital visits and substantial medical expenses. As the prevalence continues its upward trajectory, immediate attention is imperative to address this pressing public health challenge, considering potential contributing factors such as ageing, lifestyle changes and the aftermath of the COVID-19 pandemic. Our study's findings furnish crucial foundational data for shaping future prevention and treatment strategies, underscoring the urgency for effective responses to mitigate the growing impact of sleep disorders on both individual well-being and societal health.

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Contributors Conceptualisation was done by EA, YB and H-JJ. Methodology was done by EA. The original draft was written by EA. Review and editing were done by YB, J-EP, SL and H-JJ. Funding was acquired by J-EP and SL. Supervision was done by H-JJ. EA was acting as guarantor.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval The study protocol was exempted from review by the Korea Institute of Oriental Medicine's Institutional Review Board (IRB no. I-2107/006-001).

Provenance and peer review Not commissioned; externally peer reviewed.

The data that support the findings of this study are available from the Healthcare Big Data Hub of the HIRA. However, restrictions apply with regard to availability as they were used under license for research in the current study; therefore, these data are not publicly available.

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ORCID iDs

Eunyoung Ahn <http://orcid.org/0000-0003-1784-793X>

Younghwa Baek <http://orcid.org/0000-0002-1827-1701>

Siwoo Lee <http://orcid.org/0000-0003-2658-8175>

Hee-Jeong Jin <http://orcid.org/0000-0002-4373-3410>

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Supplementary table 1. The third edition of International Classification of Sleep Disorders (ICSD-3) and its diagnostic codes

Category	KCD-7*	Diagnosis
1. Insomnia	F51	Nonorganic sleep disorders
	F51.0	Nonorganic insomnia
	F51.9	Nonorganic sleep disorder, unspecified
	G47	Sleep disorders
	G47.0	Disorders of initiating and maintaining sleep
	G47.9	Sleep disorder, unspecified
2. Sleep related breathing disorders	G47.3	Sleep apnea
3. Sleep-related movement disorders	G25.8	Other specified extrapyramidal and movement disorders (restless legs syndrome)
4. Circadian rhythm sleep-wake disorders	F51.2	Nonorganic disorder of the sleep-wake schedule
	G47.2	Disorders of the sleep-wake schedule
5. Central disorders of hypersomnolence	G47.4	Narcolepsy and cataplexy
	R40.0	Somnolence
	F51.1	Nonorganic hypersomnia
	G47.1	Disorders of excessive somnolence
6. Parasomnia	F51.3	Sleepwalking
	F51.4	Sleep terrors
	F51.5	Nightmares
7. Other sleep disorders	F51.8	Other nonorganic sleep disorders
	G47.8	Other sleep disorders

* KCD, Korean Standard Classification of Diseases

Supplementary table 2. Medications for sleep disorders in South Korea

Category	Drugs with indications for sleep disorders
Benzodiazepine	Flurazepam ^a , Triazolam ^a , Flunitrazepam ^a , Brotiazolam ^a , Clonazepam
Non-benzodiazepine Non-benzodiazepine GABA modular (z-class)	Zolpidem immediate-release ^a , Zolpidem controlled-release ^a , Eszopiclone ^a
Antidepressant	Trazodone, Mirtazapine, Amitriptyline, Doxepin ^a
Antihistamine	Doxylamine ^a , Diphenhydramine ^a
Melatonin	Prolonged-release melatonin ^a
Antipsychotics	Quetiapine, Olanzapine
Herbal medicines ^a	Gamisoyo-san ^b , Hwanglyeonhaedok-tang ^b , Galgeunhaegui-tang ^b , Dangguiyukhwang-tang ^b , Sosiho-tang ^b Gwibi-tang, Sanjoin-tang, Eoggansangajinpibanha, Ongyeng-tang, Chenwangbosim-dan, Gyejigagolmoreo-tang, Ondam-tang, Samhwangsasim-tang, Galgeunhwanglyeonhwanggeum-tang, Sihogyejigeongang-tang, Seungma

^a Approved by Korea Food and Drug Administration (KFDA)

^b Medicines covered by national health insurance benefits in South Korea

Supplementary table 3. List of the 56 herbal medicines which are covered by national health insurance in South Korea

No	Korean (漢字)	Romanization of Korean	Chinese	Japanese
1	가미소요산 (加味逍遙散)	Gamisoyo-san	Jiaweixiaoyao-san	Kamishoyo-san
2	갈근탕 (葛根湯)	Galgeun-tang	Gegen-tang	Kakkon-to
3	갈근해기탕 (葛根解肌湯)	Galgeunhaegui-tang	Gegenchengqi-tang	N/A
4	구미강활탕 (九味羌活湯)	Gumiganghwat-tang	Jiuweiqianghuo-tang	Kumikyokatsu-to
5	궁소산 (芎蘇散)	Gungso-san	Qionsu-san	N/A
6	궁하탕 (芎夏湯)	Gungha-tang	Qiongha-tang	N/A
7	내소산 (內消散)	Naeso-san	Neixiao-san	Naishou-san
8	당귀연교음 (當歸連翹飲)	Dangguiyeongyo-eum	Dangguilianqiao-yin	N/A
9	당귀육황탕 (當歸六黃湯)	Dangguiyukhwat-tang	Dangguiliuhuang-tang	Tokirikuoto
10	대시호탕 (大柴胡湯)	Daeshiho-tang	Dachaihu-tang	Daisaiko-to
11	대청룡탕 (大靑龍湯)	Daechongryong-tang	Daqinglong-tang	N/A
12	대화중음 (大和中飲)	Daehwajung-eum	Dahezong-yin	N/A
13	대황목단피탕 (大黃牡丹皮湯)	Dahwangmokdanpi-tang	Dahuangmudan-tang	N/A
14	도인승기탕 (桃仁承氣湯)	Doinseunggi-tang	Taorenchengqi-tang	N/A
15	반하백출천마탕 (半夏白朮天麻湯)	Banhabakchulcheonma-tang	Banxiabaizhutianma-tang	Hangebyakujutsutenma-to
16	반하사심탕 (半夏瀉心湯)	Banhasasim-tang	Banxiaxixin-tang	Hangeshashin-to
17	반하후박탕 (半夏厚朴湯)	Banhahubak-tang	Banxiathupo-tang	Hange Koboku-To
18	백출탕 (白朮湯)	Baekchool-tang	Baizhu-tang	N/A
19	보중익기탕 (補中益氣湯)	Bojungikgi-tang	Buzhongyiqi-tang	Hochuekki-To
20	보허탕 (補虛湯)	Boheo-tang	Buxu-tang	N/A
21	복령보심탕 (茯苓補心湯)	Bokryongbosim-tang	Fulingbuxin-tang	N/A
22	불환금정기산 (不換金正氣散)	Bulhwangjeonggi-san	Buhuanjinzhengqi-san	Fukankinshoki-san
23	삼소음 (參朮散)	Samsoeum	Shensuyin	Jinsoin
24	삼출건비탕 (參朮健脾湯)	Samchulgeonbi-tang	Shenzhujianpi-tang	Sanjutsukenhi-to
25	삼호작약탕 (參胡芍藥湯)	Samhojagyak-tang	Shenhushaoyao-tang	N/A
26	삼황사심탕 (三黃瀉心湯)	Samhwangsasim-tang	Sanhuangxiexin-tang	N/A
27	생맥산 (生脈散)	Saengmaek-san	Shengmai-san	Seimiyaku-san
28	소시호탕 (小柴胡湯)	Sosihotang	Xiaochaihu-tang	Shosaiko-to
29	소청룡탕 (小靑龍湯)	Socheongryong-tang	Xiaoqinglong-tang	Shoseiryu-to
30	승양보위탕 (升陽補胃湯)	Seungyangbowi-tang	Shengyangbuwei-tang	N/A
31	시경반하탕 (柴梗半夏湯)	Sigyeongbanha-tang	Chaigengbanxia-tang	N/A
32	시호계지탕 (柴胡桂枝湯)	Sihogyegi-tang	Chaihuguiji-tang	Saikoekishito
33	시호소간탕 (柴胡疏肝湯)	Sihosogan-tang	Chaihushugan-tang	N/A
34	시호청간탕 (柴胡淸肝湯)	Sihocheonggan-tang	Chaihuqinggan-tang	N/A
35	안태음 (安胎飲)	Antae-eum	Antai-yin	N/A
36	연교패독산 (蓮翹敗毒散)	Yeonkyopaedok-san	Lianqiaobaidu-san	N/A
37	오림산 (五淋散)	Orim-san	Wulin-san	N/A
38	오적산 (五積散)	Ojeok-san	Wuji-san	Goshaku-san
39	이중탕 (理中湯)	Yijung-tang	Lizhong-tang	Richu-to
40	이진탕 (二陳湯)	Yijin-tang	Erchen-tang	Nichin-to
41	익위승양탕 (益胃升陽湯)	Ikwiseungyang-tang	Yiweishengyang-tang	N/A
42	인삼패독산 (人參敗毒散)	Insampaedok-san	Renshenbaidu-san	Ninjinheidoku-san
43	인진호탕 (茵陳蒿湯)	Injinhotang	Yinchenhao-tang	Inchin-ko-to
44	자음강화탕 (滋陰降火湯)	Jaumganghwa-tang	Ziyinjianghuo-tang	Jiinkoka-to
45	조위승기탕 (調胃承氣湯)	Jowiseunggi-tang	Tiaoweichengqi-tang	Choi-Joki-To
46	청상견통탕 (淸上蠲痛湯)	Cheongsanggyeontong-tang	Qingshangjuantong-tang	Seijokentsuto
47	청서익기탕 (淸署益氣湯)	Cheongseoikgi-tang	Qingshuyiqi-wan	N/A

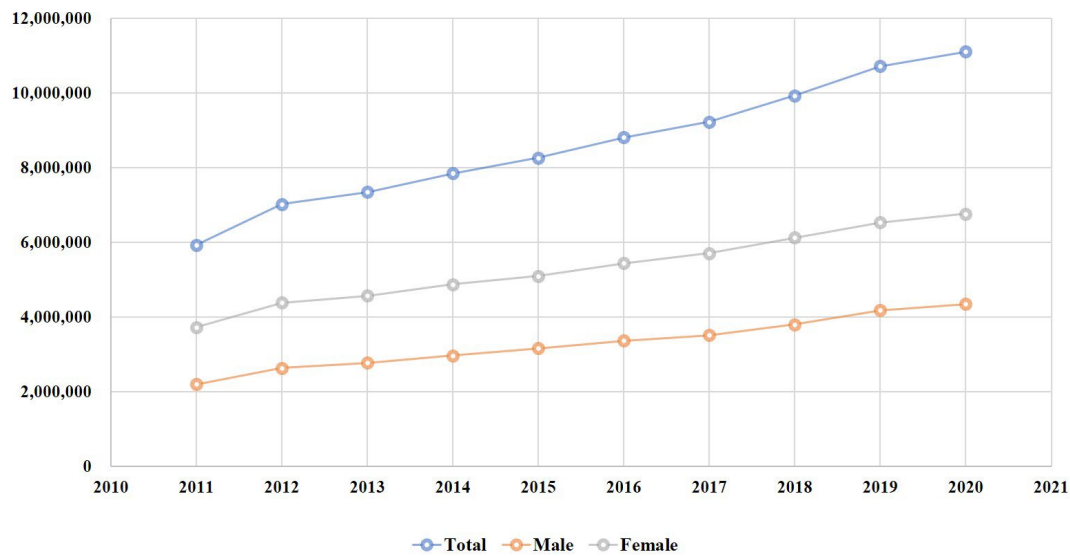
48	청위산 (淸胃散)	Cheongwi-san	Qingwei-san	N/A
49	팔물탕 (八物湯)	Palmul-tang	Bawu-tang	N/A
50	평위산 ((平胃散)	Pyeongwi-san	Pingwei-san	Heii-san
51	행소탕 (杏蘇湯)	Haengso-tang	Xingsu-tang	N/A
52	향사평위산 (香砂平胃散)	Hyangsapyeongwi-san	Xiangshapingwei-san	Koshaheii-san
53	형개연교탕 ((荊芥連翹湯)	Hyeonggaeyeongyo-tang	Jingjielianqiao-tang	Keigai-Rengyo-to
54	황금작약탕 (黃芩芍藥湯)	Hwanggeumjagyak-tang	Huangqinshaoyao-tang	N/A
55	황련해독탕 (黃連解毒湯)	Hwanglyeonhaedok-tang	Huanglianjiedu-tang	Orengedoku-to
56	회춘양격산 ((回春涼膈散)	Hoechunyanggyeok-san	Huichunliangge-san	N/A

Supplementary table 4. Annual prevalence of sleep disorders for ten years by sex (2011-2020)

Years	Total Population*	Total patient	Total prevalence (%)
2011	50,734,284	3,867,975	7.6
2012	50,948,272	4,533,300	8.9
2013	51,141,463	4,829,063	9.4
2014	51,327,916	5,196,239	10.1
2015	51,529,338	5,517,411	10.7
2016	51,696,216	5,900,528	11.4
2017	51,778,544	6,126,281	11.8
2018	51,826,059	6,552,777	12.6
2019	51,829,023	7,076,228	13.7
2020	51,667,688	7,446,846	14.4
Years	The male population*	Patient (male)	Prevalence (male, %)
2011	25,406,934	1,477,614	5.8
2012	25,504,060	1,741,659	6.8
2013	25,588,336	1,868,062	7.3
2014	25,669,296	2,016,429	7.9
2015	25,758,186	2,162,156	8.4
2016	25,827,594	2,311,577	9.0
2017	25,855,919	2,395,403	9.3
2018	25,866,129	2,578,451	10.0
2019	25,864,816	2,842,071	11.0
2020	25,841,029	2,987,309	11.6
Years	The female population*	Patient (female)	Prevalence (female, %)
2011	25,327,350	2,390,361	9.4
2012	25,444,212	2,791,641	11.0
2013	25,553,127	2,961,001	11.6
2014	25,658,620	3,179,810	12.4
2015	25,771,152	3,355,255	13.0
2016	25,868,622	3,588,951	13.9
2017	25,922,625	3,730,878	14.4
2018	25,959,930	3,974,326	15.3
2019	25,964,207	4,234,157	16.3
2020	25,826,659	4,459,537	17.3

*The population of each category is based on the population at the end of December each year published by the Ministry of the Interior and Safety's Population Data of Statistical Yearbooks.

Supplementary figure 1. Annual use of medical services for sleep disorders by sex (2011–2020)



Supplementary figure 2. Treatment prescriptions of Korean medicine, excluding herbal medicine

