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Original Article

Physical activity, smoking, and the incidence of clinically diagnosed insomnia

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ABSTRACT

Objective: This study was designed to examine the independent and combined associations of physical activity and smoking on the incidence of doctor-diagnosed insomnia using a nationally representative sample over seven years, taking into account other relevant covariates.
Methods: Participants aged 18 years or older in the 2005 Taiwan National Health Interview Survey (NHIS) with links to National Health Insurance (NHI) claim data between 2005 and 2012 and without diagnosed insomnia before 2005, were selected into this study (n = 12,728). Participants were classified as having insomnia with International Classification of Diseases, Ninth Revision (ICD-9) CM codes 307.41, 307.42, or 780.52. Self-reported smoking status and frequency, duration, and types of leisure-time and non-−leisure-time physical activities were collected. Metabolic equivalent (MET) intensity levels for each activity were assigned, and weekly energy expenditure of each activity was calculated and summed.
Results: Inactive participants had a higher risk of incident insomnia [hazard ratio (HR) = 1.22, 95% confidence interval (CI) = 1.06−1.42, p = 0.007] than the active group, and ever-smokers were more likely to have incident insomnia than never smokers (HR = 1.45, 95% CI = 1.20−1.76, p < 0.001). Compared with the nonsmoker/active group, the ever-smoker/inactive group had a higher risk of incident insomnia (HR = 1.78, 95% CI = 1.41−2.25, p < 0.001). Sensitivity analyses excluding individuals diagnosed with other sleep disorders or mental disorders yielded similar results, with the ever-smoker/inactive group having the highest risk of insomnia.
Conclusions: Inactive adults and smokers are at higher risk for incident insomnia, highlighting the importance of a healthy lifestyle and pointing to strategies such as encouraging smoking cessation and physical activity to avoid insomnia among adults.

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1. Introduction

Insomnia is a common psychological disorder, with an estimated prevalence that varies from 10% to 40%, depending on definitions [1]. Up to one-third of the general population report insomnia symptoms, including difficulties initiating or maintaining sleep, and the average prevalence of diagnosed insomnia is around six percent [2]. Insomnia is associated with an increased risk of adverse mental and physical health outcomes such as depression [3], cognitive impairment [4,5], poor self-rated health [6], and cardiovascular disease [7], as well as an impaired quality of life [8].

Smoking is also linked to a number of negative health outcomes, including cancer, cardiovascular and pulmonary diseases, anxiety disorders or symptoms, and impaired memory [9–11]. Moreover, smokers are more likely to report several insomnia-like sleep impairments (eg, insufficient sleep, longer sleep latency, poorer sleep quality) than nonsmokers [10,12,13]. Longitudinal studies have found that adult smokers who began smoking in adolescence have an increased risk of insomnia [14], and continuous heavy smoking in women is associated with an increased likelihood of insomnia in late mid-life [15].

By contrast, physical activity appears to be beneficial for sleep and is associated with increased total sleep time and sleep efficiency, decreased sleep latency, and improved sleep quality [16,17]. It is thought that physical activity may be valuable for improving sleep outcomes among individuals with sleep difficulties, as well as

in those diagnosed with insomnia [18–20]. It has also been suggested that physical activity may help reduce the incidence of insomnia symptoms [21,22].

Most population studies investigating risk factors for insomnia incidence have used simple questions to define insomnia [21,23], which may lead to some degree of misclassification. Formal diagnoses of insomnia provide a stronger basis on which to manage the condition, but epidemiological studies involving insomnia diagnoses are limited [2]. One longitudinal study examined risk factors for diagnosed insomnia, but focused on the demographic correlates of the condition and did not include physical activity or smoking status in the analyses [24].

Because physical inactivity, smoking, and insomnia are associated with a range of physical and psychiatric disorders, understanding their relationship may help to promote public health. Additionally, if physical activity and not smoking are beneficial for sleep, combining the two behaviors may be valuable in the prevention of insomnia. This study was therefore designed to examine the independent and combined associations of physical activity and smoking on the incidence of doctor-diagnosed insomnia using a nationally representative sample over a period of seven years, taking into account other relevant covariates.

2. Methods

2.1. Study population

Participants were selected from the 2005 National Health Interview Survey (NHIS), conducted by the National Health Research Institutes and Bureau of Health Promotion, Taiwan. This is a periodic nationwide survey using a multi-stage stratified systematic sampling design to select a nationally representative sample [25]. A total of 24,726 participants were included in the 2005 NHIS, with a response rate of 80.59%. The NHIS data were linked to the 2005–2012 claims data in the National Health Insurance (NHI) Research Database. The NHI is a public compulsory insurance system for all citizens covering more than 99% of Taiwan's population [26,27].

Participants who 18 years or older in the NHIS (n = 18,529) provided consent to link their NHI claim data (n = 13,926), and who were not diagnosed with insomnia before 31 December 2005, were selected for this study (n = 12,728). The study was approved by the Taichung Veterans General Hospital Institutional Review Board, Taiwan. To ensure adequate data protection, all data access and statistical analyses were conducted in the Health and Welfare Data Science Centre, Ministry of Health and Welfare, Taiwan.

2.2. Definition of clinical insomnia

Participants were classified as having insomnia if they had any of the following insomnia-related International Classification of Diseases, Ninth Revision (ICD-9) CM codes: 307.41, 307.42, or 780.52, based on the claim data from the NHI Research Database. Participants who were newly diagnosed as having insomnia between 2006 and d2012 and who had not been defined as having insomnia for at least two years before 31 December 2005 were considered incident cases. The date of diagnosis of insomnia was recorded.

2.3. Physical activity

Leisure-time and non−leisure-time physical activity were self-reported in the 2005 NHIS. Leisure-time physical activity was assessed by the following question: "Did you participate in any leisure-time physical activities during the last two weeks?"

Respondents were asked to identify the activity types that they engaged in from 31 named activities (eg, Tai Chi, walking, jogging, swimming) and were able to specify up to five types. Frequency and duration for each activity were also collected, and metabolic equivalent (MET) intensity levels for each activity were assigned [28]. Weekly energy expenditure (kcal) of each activity was calculated by the following: activity intensity code (kcal/min) × frequency per week (times) × duration for each time (minutes). These were then summed to provide a total weekly amount of energy expenditure for leisure-time activity.

Participants were also asked: "Did you participate in any non−leisure-time physical activity during the last two weeks?" They were asked to identify the activity types that they engaged in from 10 named activities (eg, farm or fishing work, heavy lifting, household chores) and could specify up to five types. The total weekly amount of energy expenditure for non−leisure-time physical activity was calculated as described above. The leisure time and non−leisure-time physical activity were then summed to provide weekly energy expenditure for overall physical activity, which was grouped into two levels (inactive: 0−999 kcal/wk; active: ≥1000 kcal/wk) based on international recommendations [29]. These physical activity measures have been used in previous work [25,30,31].

2.4. Smoking status

The following questions were asked in order to assess smoking status in the 2005 NHIS: "Have you ever smoked?" and "Did you smoke during the past month?" Participants were classified as "current smokers" if they reported that they had ever smoked and smoked during the past month. Those who answered that they had ever smoked but did not smoke during the past month (quit smoking) were classified as "former smokers." Others who had never smoked were grouped into "never-smokers." As the percentage of former smokers was very small (4.7%), and as only 57 of them were identified as developing insomnia, both the current and former smokers were combined and are subsequently referred to as "ever-smokers."

2.5. Covariates

The following variables in 2005 NHIS (at baseline) were selected as covariates based on previous research [23,32]: (1) socio-demographic variables: sex, age (18−44, 45−64, ≥65 years), education level (≤primary school, high school, ≥college), marital status (married/cohabitating, never married, others), and monthly household income (US dollars) (<1000, 1000−2333, ≥2333); (2) health-related variables: alcohol consumption (yes vs no), weight status (body mass index [BMI]: <18.5, 18.5−23.9, 24−26.9, ≥27) [33], and the Charlson Comorbidity Index (0, 1−2, ≥3), which is based on the number and severity of diseases [34,35].

2.6. Ethical approval

This study was approved by the Taichung Veterans General Hospital Institutional Review Board, Taiwan (reference number SE14257A-1). All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

2.7. Data analysis

Descriptive statistics for each variable at baseline in 2005 by insomnia incidence between 2006 and 2012 were calculated to