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Utility of overnight pulse oximeter as a screening tool for sleep apnea to assess the 8-year risk of cardiovascular disease: Data from a large-scale bus driver cohort study

Wei-Te Wu [a], Su-Shan Tsai [b], Yu-Jen Lin [c], Ming-Hsiu Lin [d], Trong-Neng Wu [a,e], Tung-Sheng Shih [d], Saou-Hsing Liou [a,f,g,*]

[a] National Institute of Environmental Health Sciences, National Health Research Institutes, Miaoli, Taiwan
[b] Graduate Institute of Life Sciences, National Defense Medical Center, Taipei, Taiwan
[c] Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, Taipei, Taiwan
[d] Institute of Labor, Occupational Safety and Health, Ministry of Labor, Taipei, Taiwan
[e] Department of Healthcare Administration, Asia University, Taichung, Taiwan
[f] Department of Occupational Safety and Health, China Medical University, Taichung, Taiwan
[g] Department of Public Health, National Defense Medical Center, Taipei, Taiwan

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ABSTRACT

Background: Professional drivers' work under conditions predisposes them for development of sleep-disordered breathing (SDB) and cardiovascular disease (CVD). However, the effect of SDB on CVD risk among professional drivers has never been investigated. A cohort study was used to evaluate the effectiveness of overnight pulse oximeter as a sleep apnea screening tool to assess the 8-year risk of CVD events.
Methods: The Taiwan Bus Driver Cohort Study (TBDCS) recruited 1014 professional drivers in Taiwan since 2005. The subjects completed questionnaire interview and overnight pulse oximeter survey. This cohort was linked to the National Health Insurance Research Dataset (NHIRD). Researchers found 192 CVD cases from 2005 to 2012. Cox proportional hazards model was performed to estimate the hazard ratio for CVD. The statistical analysis was performed using SAS software in 2015.
Results: ODI4 and ODI3 levels increased the 8-year CVD risk, even adjusting for CVD risk factors (HR: 1.36, 95% CI: 1.05 to 1.78; $p = 0.022$, and HR: 1.40, 95% CI: 1.03 to 1.90; $p = 0.033$). ODI4 and ODI3 thresholds of 6.5 and 10 events/h revealed differences of CVD risks (HR: 1.72, 95% CI: 1.00 to 2.95; $p = 0.048$, and HR: 1.76, 95% CI: 1.03 to 3.03; $p = 0.041$). Moreover, the ODI levels had an increased risk for hypertensive disease (not including essential hypertension).
Conclusions: This study concludes that ODI for a sign of SDB is an independent predictor of elevated risk of CVD. Further research should be conducted regarding measures to prevent against SDB in order to reduce CVD risk in professional drivers.

1. Introduction

Cardiovascular disease (CVD) is not only the number one cause of death worldwide, but it is also one of the compensable work-related diseases [1,2]. Therefore, except for the common CVD risk factors including smoking, hypertension, diabetes, hyperlipidemia, obesity, physical inactivity or diet [1,2], the work environment factors in professional drivers, such as irregular work shifts, long hours of driving, sedentary restricted postures, long-term sleep deficiency, noise and chemical exposures [3–8], also have increased the probability of developing CVD [6,9–12].

Recently, sleep-disordered breathing (SDB) is increasingly being recognized as an important factor contributing to the burden of CVD [13–19]. SDB is a sleep disorder that involves cessation or a significant decrease in airflow in the presence of breathing effort, and causes recurrent oxyhemoglobin desaturations and arousals from sleep. SDB has been shown to be more common among professional drivers, which is likely because physical inactivity or unhealthy diet choices cause obesity, and irregular work schedules or long working hours cause circadian rhythm disruption and chronic sleep deficiency [3,4,20]. Previous studies identified that about 28.2% of professional drivers from the USA [21], 15.8% of professional drivers from Australia [20], and 10% of bus drivers from both the UK [22] and Hong Kong [23] suffered from

* Corresponding author at: National Institute of Environmental Health Sciences, National Health Research Institutes, 35 Keyan Road, Zhunan Town, Miaoli County, 35053, Taiwan.
E-mail address: shliou@nhri.org.tw (S.-H. Liou).

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sleep apnea, in contrast to 3%–7% prevalence of OSA within the general male population [24]. It is a significant labor health concern when one considers the relatively high and rising prevalence of SDB in this high-risk occupation.

Importantly, SDB is a treatable disease; therefore, studies on whether or not SDB contributes to or exacerbates CVD, could support a novel target for cardiovascular risk reduction in professional drivers. However, reviewing a previous study that related to the effect of SDB on CVD development in professional drivers has never been systematically investigated. Additionally, several problems were shown in this research field, including an incomplete CVD data collection, small sample sizes, and poor control for confounding factors, which limited the assessment of an independent pathogenic role for SDB, and did not show clear causal association. Thus, we performed a perspective cohort study to evaluate the effectiveness of overnight pulse oximeter as a sleep apnea screening tool to assess the 8-year risk of CVD events. We hypothesized that the oxygen desaturation index would predict CVD and CVD events such as hypertensive disease, ischemic heart disease (IHD), cerebrovascular disease, diseases of arteries, arterioles, and capillaries, and congestive heart failure (CHF), and that the associations would persist after adjusting for CVD risk factors.

2. Methods

2.1. Study population

The study procedure is presented in Fig. 1. The Taiwan Bus Driver Cohort Study (TBDCS) included 1650 professional drivers from the largest transportation companies in Taiwan. First, we used this cohort to link the Driving Hours Dataset (total number of records = 1,518,350 person-times) based on the Event Data Recorder from 2005 to 2007. We selected 1037 professional drivers whose total driving period exceeded 100 days during the 3 years after undergoing an assessment questionnaire interview and biochemistry examination. Twenty-three subjects with no completed assessment questionnaire were excluded. The remaining 1014 drivers completed the overnight pulse oximeter survey for evaluating the risk of SDB. These 1014 subjects were linked to the ambulatory care expenditures-by-visits and inpatient expenditures-by-admissions data from the National Health Insurance Research Dataset (NHIRD), and 192 CVD drivers (ICD-9-CM: 390–459) and 822 non-CVD drivers were found from 2005 to 2012. The selection criteria for CVD cases were that study subjects had at least five clinical visit records within a year or at least one inpatient record in the first-listed diagnosis code.

This study was approved by the Institutional Review Board of the National Health Research Institutes and Tri-Service General Hospital, Taiwan. After the written informed consent was obtained from individual participants they responded to a structured interview. The interview assessed information on socio-demographic characteristics (age, ethnicity, marital and education status), work conditions (year of first employment and bus driving experience), and lifestyle habits (smoking, drinking, exercise, refreshing drinks and medicine use), and job stress assessment questionnaires were collected. Each participant also underwent a venous blood draw a biochemical screening test during the health examination. Two blood pressure recordings (systolic blood pressure (SBP) and diastolic blood pressure (DBP)) were obtained from the right arm of subjects while they were in a sitting position after 15 min of rest at 5-minute intervals, and their mean value was calculated.

2.2. Biochemical measurements

Blood samples were collected by venipuncture, centrifuged at room temperature and immediately used for batch analysis for high-sensitivity C-reactive protein (hs-CRP) activity and homocysteine (HCY). Hs-CRP and HCY were measured using an Immulite® 2000 system (Diagnostic Products Corporation, Los Angeles, CA, USA).

Biochemical analysis of fasting blood glucose (FG) was conducted using Hexokinase method on an AU640 analyzer (Beckman Coulter Ltd., High Wycombe, UK). For the determination of total cholesterol, the assay employed the cholesterol oxidase method on an AU640 analyzer (Beckman Coulter Ltd., High Wycombe, UK). Triglyceride (TG) concentration was determined using an enzymatic method on an AU640 analyzer (Beckman Coulter Ltd., High Wycombe, UK). High-density lipoprotein cholesterol (HDL-

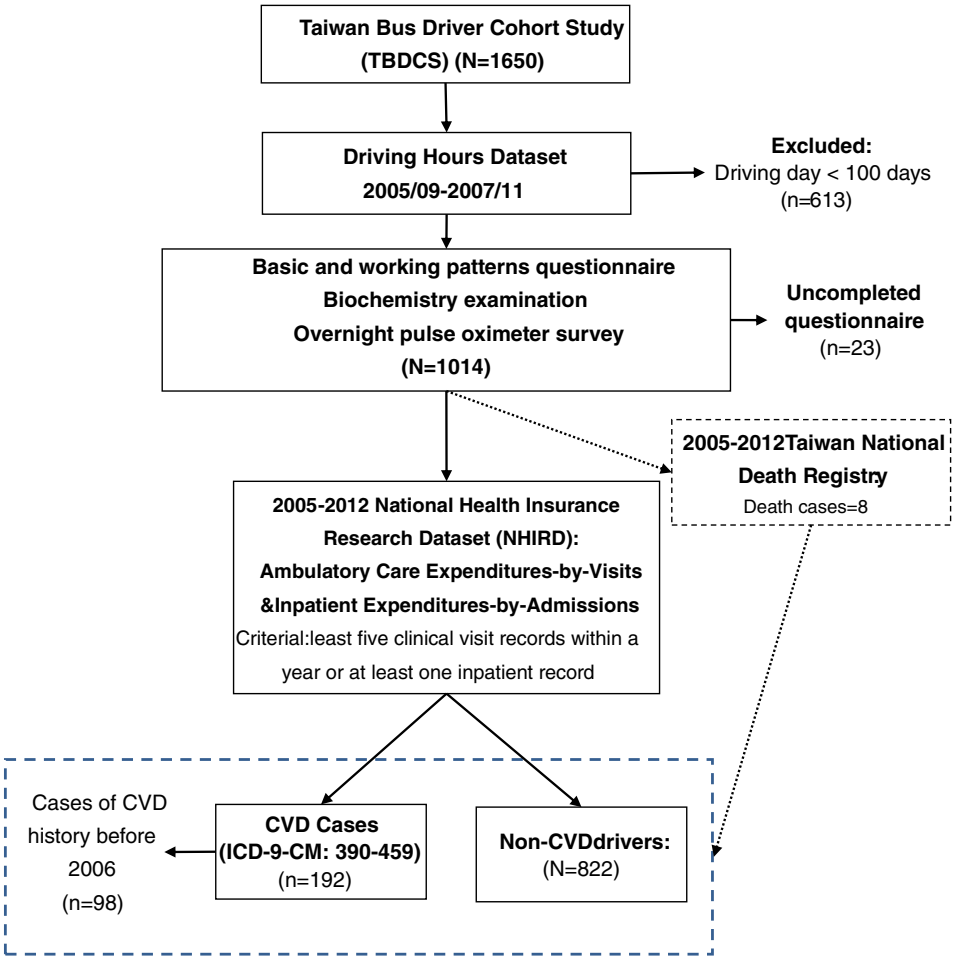

Fig. 1. Study flow diagram.