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ORIGINAL ARTICLE

Sleep-disordered Breathing in Cardiac Rehabilitation: Prevalence, Predictors, and Influence on the Six-Minute Walk Test

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Background Identification of non-traditional risk factors is an important component of cardiac rehabilitation (CR). However, the prevalence and predictors of sleep-disordered breathing (SDB) and its influence on exercise performance in patients attending CR remain poorly described.

Methods Patients enrolled in a national CR centre were eligible for a comprehensive SDB screening program. Screening questionnaires for SDB, overnight sleep study, and the 6-minute walk test (6MWT) were conducted.

Results We recruited 332 patients (mean age 62±10 years, 62.4% male) attending CR for primary (29.2%) or secondary (70.8%) prevention, of which 209 successfully completed the overnight sleep study. Sleep-disordered breathing group patients (n=68, 32.5%) were older and had a higher body mass index (BMI) and neck and waist circumferences than the non-SDB group patients. After adjusting for neck and waist circumference, age (OR=1.06; 95% CI 1.02–1.10; p=0.001) and BMI (OR=1.19; 95% CI 1.10–1.30; p<0.001) remained independent predictors of SDB. A high risk of SDB based on the Berlin Questionnaire (43.4% versus 35.5%, p=0.277) or STOP-BANG questionnaire (63.2% versus 53.2%, p=0.170) and excessive daytime sleepiness (Epworth Sleepiness Scale >10, 23.9% versus 17.7%, p=0.297) were similar between the groups. The 6MWT scores were significantly lower in the SDB than non-SDB group (mean difference -32 m; 95% CI -57–7; p=0.013). The relationship was no longer significant after adjusting for age, sex, and waist circumference.

Conclusion Sleep-disordered breathing is prevalent in CR patients and is independently predicted by ageing and obesity. The association between SDB and poorer exercise performance may be explained by age, sex, and waist circumference.

Keywords Rehabilitation • Sleep • Screening • Exercise performance • Predictors • Cardiology

Introduction

Prevention and rehabilitation of cardiovascular disease is an integral part of the global healthcare regimen. Early identification and treatment of cardiovascular risk factors in the form of supervised exercise training and education classes have been shown to be effective in improving exercise performance and prolonging survival in patients with

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cardiovascular disease [1,2]. Sleep-disordered breathing (SDB), characterised by the repetitive cessation of ventilation during sleep, is a prevalent but under-recognised disorder associated with activation of the sympathetic nervous system and inflammatory response, endothelial dysfunction, and increased oxidative stress [3]. It is estimated that 12–18 million adults may have untreated SDB in the United States (US) alone. In recent years, SDB has been recognised as a modifiable risk factor for cardiovascular disease. The association between SDB and cardiovascular morbidity and mortality has been widely reported [4–6], and epidemiological studies have noted a reduction in cardiovascular events with screening for and treatment of SDB [7–9].

In this regard, the American College of Cardiology/American Heart Association and the European Society of Cardiology have issued statements to highlight the emerging roles of SDB in cardiovascular risk stratification and treatment guidelines [10,11]. Nevertheless, screening for SDB in patients hospitalised for cardiovascular disease is rarely performed, likely due to a lack of awareness amongst cardiologists [12]. Compared with hospitals in which physicians are focussed on treating acute conditions, outpatient cardiac rehabilitation (CR) centres may be a better setting within which to conduct screening programs for SDB. At present, data regarding SDB in patients attending CR are sparse [13–15]. Furthermore, the relationship between SDB and exercise performance remains unclear.

Previous studies on SDB screening in CR used screening questionnaires rather than sleep studies to diagnose SDB [13,14]. However, the use of screening questionnaires to identify SDB in patients with cardiovascular disease can be unreliable [16,17]. Full in-laboratory polysomnography remains the gold standard diagnostic tool for SDB. However, it is often limited by availability, cost and a need of a trained technologist for result interpretation. As such, the use of portable devices to diagnose SDB, in contrast to full in-laboratory polysomnography, has been gaining popularity [18]. We sought to determine both the prevalence and predictors of SDB and the relationship between SDB and exercise performance using a US Food and Drug Administration-approved wrist-worn portable sleep study device in patients undergoing CR. We also evaluated the usefulness of three commonly used screening questionnaires for SDB in patients attending CR.

Methods

Study Design and Patient Population

This was a prospective study conducted at the Singapore Heart Foundation (SHF) Heart Wellness Centre, a national institution in Singapore that runs a late-phase, community-based Heart Wellness Program. The late-phase CR comprises a lifetime maintenance phase in which physical fitness and additional risk-factor reductions are emphasised. The SHF Heart Wellness Centre accepts referrals for primary (high cardiovascular risk: hypertension, diabetes, hyperlipidaemia, and obesity) and secondary (coronary artery disease, valvular heart disease, cardiac arrhythmias, and stable chronic heart failure) cardiovascular disease prevention by the patient's respective cardiologist or family physician. Completing the early-phase CR is not a prerequisite for enrolment. Patients enrolled in the SHF Heart Wellness Centre for outpatient CR were systemically screened for inclusion in this study. The exclusion criteria comprised patients with known SDB who were currently receiving treatment, those with a language barrier, patients unable to provide informed consent, clinically significant arrhythmia, peripheral artery disease, or patients currently on α-adrenergic blockers. Eligible patients were invited to join a comprehensive SDB screening program where (1) screening questionnaires, (2) an overnight sleep study, and (3) the 6-minute walk test (6MWT) were performed. The overnight sleep study was strongly encouraged irrespective of the results of the screening questionnaires, but its refusal did not preclude participation. The study protocol was approved by the local institutional review board (Parkway Independent Ethics Committee 2013/027, approved on November 26, 2013), and all of the subjects provided their written informed consent.

Assessments and Data Collection

Baseline demographical and clinical characteristics were collected for all recruited patients from the SHF Heart Wellness Centre database. This was based on medical records provided by the patient's referring hospital/general practitioner during enrolment into the cardiac rehabilitation program. The following parameters were collected: sex, age, ethnicity, body mass index, neck circumference, waist circumference, primary indication for CR, cardiovascular risk factors (smoking, hypertension, diabetes mellitus, hyperlipidaemia, and family history of coronary artery disease), and medical history (previous myocardial infarction, previous percutaneous coronary intervention, previous coronary artery bypass surgery, previous stroke, and chronic renal failure).

Screening Questionnaires

All recruited patients completed three screening questionnaires for SDB: the Berlin Questionnaire, the STOP-BANG questionnaire, and the Epworth Sleepiness Scale. The Berlin Questionnaire consists of 10 questions in three categories, which evaluate snoring and snoring intensity, daytime somnolence, and the presence of obesity or hypertension, respectively. A positive score in two or more categories indicates a high risk of SDB [19]. The STOP-BANG questionnaire includes four yes/no questions on the presence of snoring, daytime sleepiness, observed apnoeas, and hypertension and four demographical questions for body mass index, age, neck circumference, and sex. A total STOP-BANG score of three or greater implies a high risk of SDB [20]. The Epworth Sleepiness Scale is a validated screening tool that assesses the presence of daytime sleepiness by examining the perceived likelihood of falling asleep in eight daytime situations [21]. An Epworth Sleepiness Scale score > 10 denotes excessive daytime sleepiness.