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Sleep quality among elderly high-altitude dwellers in Ladakh

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ABSTRACT

It has been already known that people who temporarily stay at high altitude may develop insomnia as a symptom of acute mountain sickness. However, much less is known about people living at high altitude. The aim of this study was to determine the effect of high altitude environment on sleep quality for the elderly who have been living at high altitude for their whole lives. A cross-sectional study was conducted in Domkhar valley at altitudes of 2800–4200 m, Ladakh. Sleep quality was assessed using Insomnia Severity Index (ISI). Measurement items include body mass index, blood pressure, blood sugar, hemoglobin, timed Up and Go test, oxygen saturation during wakefulness, respiratory function test, Oxford Knee Score (OKS), and Geriatric Depression Scale (GDS), and so on. The participants were Ladakhi older adults aged 60 years or over (n=112) in Domkhar valley. The participation rate was 65.1% (male: female=47:65, mean age: 71.3 years and 67.9 years, respectively). The prevalence of the high score of ISI (8 or more) was 15.2% (17 out of 112). Altitude of residence was significantly correlated with ISI. Stepwise multiple regression analysis showed that OKS and altitude of residence were significantly related with ISI.

1. Introduction

The studies about the effect of high altitude on sleep have undergone a long history. Abnormal breathing during sleep was observed in 1857 during the ascent of Mont Blanc by John Tyndall and his friends, Angelo Mosso recorded the periodic breathing in 1898 by measuring the breathing movements of chest during sleep in the Regina Margherita Hut at the altitude of 4559 m, and Joseph Barcroft conducted intensive studies about anoxaemic sleeplessness using glass case experiments in 1920s (West et al., 2007). It has been reported that at high altitude, sleep onset time, frequency of arousals, and light sleep (stages I and II of non-rapid eye movement (NREM) sleep) appear to be increased. On the other hand, rapid eye movement (REM) sleep and slow wave sleep (SWS) appear to be decreased (Ainslie et al., 2013).

In this study, we conducted comprehensive geriatric assessments for the community dwelling elderly in Domkhar valley, Ladakh to determine the effect of high altitude on sleep quality. The risk of sleep disturbance increases with age. Decreased total sleep time, SWS, REM sleep and sleep efficiency, and increased awakenings, time awake after sleep onset and NREM sleep have been observed with advancing age (Vaz Fragoso and Gill, 2007). Although there were numerous reports on physiological experiments about the relationships between hypoxia and sleep for sojourners to high altitude, few studies have been conducted for people born and living long at high altitude (Selvamurthy et al., 1986; Coote et al., 1992; Arai et al., 2002). Selvamurthy et al. reported that high altitude natives also had lesser amounts of slow wave sleep at high altitude but they had relatively reduced level of sympathetic activity and the arousals and awakenings

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during sleep were less frequent than sojourners (Selvamurthy et al., 1986). Coote et al. reported that the mean periods of slow wave sleep were 74.6 min in five high altitude natives aged under 40 and 9.7 min in three high altitude natives aged over 40 (Coote et al., 1992). Arai et al. measured arterial oxygenation during sleep in 61 Sherpa highlanders living at 3450–3850 m above sea level and reported that lower mean arterial oxygen saturation during sleep and presence of periodical fluctuation were significantly related with older age (Arai et al., 2002). These reports suggest that sleep quality is important issue especially for the elderly living at high altitude. Assessment of sleep quality can be an essential component of Comprehensive Geriatric Assessment (CGA). In this study, we tried to reveal the effect of high altitude environment on sleep quality for the elderly who have been living at high altitude for their whole lives and analyzed the relation with other CGA components.

2. Methods

2.1. Subjects

Ladakh is the highest plateau of state of Jammu and Kashimir, surrounded by the Himalayan and Karakoram mountain ranges. Domkhar valley is located about 4–5 h drive northwest from Leh, the central city of Ladakh region in the north-western part of India. The altitude varies from 2800 to 4200 m. The partial pressure of inhaled oxygen is decreased by 30–40% and the temperature often reaches −30 °C in winter. During the winter season, extreme coldness makes people stay indoors and people pray to God inside their houses (Sakamoto et al., 2016). Around April, people in Domkhar valley plowed the fields with *zho*, a male hybrid of cattle and yak that is well adapted for thin air and low temperatures. They enjoyed *chhang*, an alcoholic beverage made from barley, as they cultivate the land. In July, greeneries and flowers spread along the riverbank and people waited for the barley harvest season.

In July 2008 and April 2009, we conducted preliminary survey in Domkhar valley to grasp the need of the villagers. From July 17th, 2009, we stayed at Domkhar valley and recruited the volunteers who participate into the medical checkups through the local leaders. From July 18th to July 27th, 2009, the medical checkups were conducted. The total population and the population aged 60 years or over have been reported to be 1269 and 172 respectively in the valley (Yamaguchi et al., 2013). Out of them, thirteen (7.6%) people did not participate into the medical checkups because they were absent from Domkhar valley in the long term. Forty two (24.4%) people did not participate into the medical checkups because they had other things to do or not willing to join. Four (2.3%) people participated into the medical checkups but ISI was not completely done. We excluded one (0.6%) person who participated into the medical checkups because of the person had a severe anemia. After all, 112 community-dwelling older adults aged 60 years or over out of a total of 172 people aged 60 years or over living in Domkhar valley participated into the study. The participation rate was 65.1%; male: female=47:65, mean age: 71.3 ± 7.0 years for male and 67.9 ± 6.5 years for female (Table 1).

2.2. Procedures

2.2.1. Assessment of insomnia, knee arthritis, and respiratory function

Assessment of insomnia was performed using Insomnia Severity Index (ISI) which is a brief self-report instrument for insomnia. The ISI consists of seven items assessing the severity of sleep onset, sleep maintenance, early morning awakening problems, sleep dissatisfaction, interference with daily functioning, noticeability of sleep problems by others, and degree of distress or concern caused by the sleep problems. Each item is rated on a 0–4 scale and the total score ranges from 0 to 28 (Bastien et al., 2001). A higher score suggests more severe insomnia as follows: 0–7=no clinically significant insomnia; 8–14=subthreshold insomnia; 15–21=clinical insomnia (moderate severity); 22–28=clinical insomnia (severe). Lhadakhi writing has been the lack of a generally accepted written version of the spoken language and it is in the process of developing into a standard written language (Bray, 1998; Koshal, 2005). In this study, the English version of ISI was interpreted into Ladakhi colloquial and conducted questionnaire. Cronbach's alpha of this method was 0.845, with item-to-total correlations in the range of 0.251–0.750.

Assessment of knee arthritis was performed using Oxford Knee Score (OKS) which contains 12 questions. Each item is scored from 0 to 4 with 4 being the best outcome and combined to produce a single score with a range from 0 (most difficulties) to 48 (least difficulties) (Dawson et al., 1998). The respiratory function test was performed including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), using EasyOne handheld spirometer (ndd Medical Technologies, Zürich, Switzerland), which measures gas flow by ultrasound waves. Oxygen saturation was measured during wakefulness by use of a pulse oximeter, Ubix-ST (UBIX Corporation, Tokyo, Japan). Altitude of residence was determined by using satellite images of GeoRPC (GeoEye, Virginia, U.S.A.) and information from residents, analyzed by ArcGIS 10.0 (Esri, California, U.S.A).

2.2.2. Geriatric functions

Participants were interviewed to obtain information about their symptoms, demographic characteristics, medical history, family structure, tobacco use, and alcohol use. This provided information about the following variables: age, sex, height, weight, blood pressure, heart rate, fasting blood sugar, hemoglobin, serum lipid, serum albumin, serum creatinine, timed Up and Go test, functional reach test, basic ADL, the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) (Mathias et al., 1986; Weiner et al., 1990; Koyano et al., 1991; Matsubayashi et al., 1999).

Blood pressure was measured twice in a sitting position using an auto-sphygmomanometer (HEM 757; Omron, Japan). Hypertension was defined as a systolic pressure of 140 mmHg or higher, or diastolic pressure as 90 mmHg or higher, or as one taking antihypertensive medication. Blood chemical tests were conducted twice, at fasting and 2 h after drinking 75 g of glucose, among subjects who provided informed consent. Diabetes mellitus and impaired glucose tolerance were defined according to World Health Organization criteria. Specifically, diabetes mellitus was defined as a fasting blood sugar (FBS) of 126 mg/dL or greater or 2-h oral glucose tolerance test (OGTT) of 200 mg/dL or greater, or if the subject was taking diabetes medication, and impaired glucose tolerance was defined as an FBS from 110 mg/dL to 126 mg/dL or an OGTT from 140 to 200 mg/dL. Insulin resistance was assessed using the homeostasis model assessment insulin resistance index (HOMA-R) and was calculated as fasting plasma glucose×fasting serum insulin/405 (Matthews et al., 1985).

The timed Up and Go test measured, in seconds, the time it took a participant to stand up from an armchair, walk a distance of 3 m, turn around, walk back to the chair, and sit down (Mathias et al., 1986). The functional reach test assessed balance in these older adults. Participants stood with their fist extended alongside a wall. They were required to lean forward as far as possible, moving their fist along the wall without taking a step or losing their balance. The length of their fist movement was measured (Weiner et al., 1990). As a screening test for depressive symptoms, the 15-item version of the Geriatric Depression Scale (GDS) was used (Burke et al., 1991). Ankle brachial pressure index (ABI) and the cardio ankle vascular index (CAVI) were measured using a Va Sera instrument (Fukuda Denshi, Tokyo, Japan).

We included foregoing demographic information, anthropometrics, laboratories, arterial stiffness, respiratory functions, and geriatric functions because sleep disturbance is reported to be associated with living separately, smoking and drinking habit, hypertension, obesity, diabetes, respiratory symptoms, body pain, depression, physical dis-