

# The Effect of The Plateau Environment on The Sleep Quality of Migrant Han Chinese

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## Abstract

Good sleep is an important physiological requirement for maintaining physical and mental health. With the development of economy, more and more people from the plains have moved to the plateau, and the plateau special environment has a great impact on the sleep of the migrants, most of which are manifested as decreased sleep quality, frequent awakenings at night, and decreased daytime work ability. Combined with domestic and foreign studies, this paper elaborated the impact of plateau sleep on various body systems, sleep quality under plateau environment and the relationship between plateau sleep and acute and chronic altitude diseases, and then comprehensively evaluated the impact of plateau environment on sleep quality of emigrated population, providing theoretical basis for further exploration of plateau sleep strategies.

## Keywords

Plateau; Sleep; Emigrant Han.

## 1. PLATEAU ENVIRONMENT AND SLEEP

The plateau natural environment is special, with low air pressure, low oxygen content, large temperature difference between day and night, strong ultraviolet rays and other characteristics. The Qinghai-Tibet Plateau is the highest plateau in China with an average altitude of 4000 m. The partial pressure of atmospheric oxygen in most areas is lower than 60% of sea level, and the low-pressure, low-oxygen environment can have different degrees of effects on various human systems [1]. With its unique geographical location and climatic conditions, the plateau seriously affects human physiological and psychological health, including different degrees of plateau recession, and acute and chronic plateau diseases can occur in severe cases, with plateau pulmonary edema and cerebral edema, endangering human life and health [2].

About one-third of a person's life is spent on sleep, and high-quality sleep is the most basic physiological need of the human body. Studies have shown that sleep deprivation impairs cognitive function, reduces daytime learning ability [3], and can lead to adverse emotions such as anxiety and depression [4]. High reason for its special geographical environment, the impact on human sleep quality is very obvious, for the plain people who rush into the plateau, low oxygen will cause sleep disorders, and then aggravate the performance of acute plateau reaction. For the plain people who move to the plateau for a long time, the sleep disorder not only affects people's ability to work during the day, but also affects the quality of survival, and can cause various psychological and physiological diseases. It is found that the body state in the plateau environment is essentially the hypoxic stress response, and sleep, as an important monitoring indicator of hypoxic adaptation, can reflect to a certain extent the adaptation of the body to the plateau environment, and good sleep can make the body more adapted to the hypoxic

environment, while poor sleep will prolong the process of adaptation, and even aggravate the plateau hypoxic stress response [5].

## 2. THE EFFECT OF HIGH ALTITUDE SLEEP ON THE BODY SYSTEMS

It is generally believed that the central nervous system is the first to be affected by the hypoxic environment in the plateau, and the sleep disorder in the plateau is mainly caused by hypoxia, while the sleep is dominated by the central nervous system, so the degree of the central nervous system affected better reflects the effect of hypoxia on sleep in the plateau. Neurons are most sensitive to hypoxemia, and the mechanisms of impaired neuronal function during hypoxia include alterations in ion homeostasis, alterations in calcium metabolism, alterations in neurotransmitter metabolism, and impairment of synaptic function [6-8]. A large number of existing studies have shown that hypoxia can reduce cognitive function and that the hypoxic environment of the plateau affects central nervous system function, which in turn causes changes in sleep architecture, leading to insomnia and sleep disorders, the results of which can exacerbate central nervous system dysfunction and reduce adaptation to the plateau environment, among others [9]. Previous studies have found that high altitude exposure can cause impairment of sleep patterns, resulting in decreased vitality, concentration, and executive function capacity [10]. Some studies have shown that people living at high altitudes have serious sleep disorders and a tendency to decline in brain activity, the magnitude of which is significantly correlated with altitude and the length of time spent on the plateau [11], and the effects of plateau hypoxia on cognitive functions are specifically manifested as decreased attentional capacity, decreased short-term memory, and decreased thinking [12,13].

A study showed that the incidence of insomnia among plateau stationed officers and soldiers in China was 52.53% [14], and their sleep quality and each factor score showed a significant negative correlation with cognitive level indicators, indicating that the sleep quality of plateau stationed officers and soldiers has a direct impact on their cognitive level. Insomniac officers and soldiers have difficulty falling asleep, wake up frequently during sleep, and the proportion of slow-wave sleep decreases, all of which can cause dysfunction of the hypothalamic-pituitary-adrenal axis and affect the brain neurotrophic factors to provide nutritional support to neurons and glial cells, thus leading to impairment of cognitive function [15]. On the other hand, insomnia also impairs cognitive function by reducing blood flow to the prefrontal cortex of the brain [16], and some studies have shown that increasing cerebral blood flow reduces the severity of sleep apnea at high altitude [17], and the degree of cognitive impairment in high altitude populations, who commonly suffer from insufficient sleep duration and poor sleep quality, also appears to be impaired to some extent [18].

The quality of sleep in the plateau is also related to people's psychological health, and current research shows that the quality of sleep of plateau soldiers is closely related to their psychological health, and the poorer the quality of sleep, the worse their psychological health [19], and research shows that the poorer the quality of sleep of plateau soldiers, the more serious the anxiety and depression symptoms [20]. It has also been shown that there is a strong link between sleep quality and depression and anxiety symptoms among college students, and the groups with high prevalence of depression and anxiety symptoms are also the groups with sleep disorders [21]. In a study investigating the sleep quality and mental health status of medical personnel stationed in training on a plateau in a ministry, it was found that the worse the sleep quality, the worse the mental health status [22]. All of the above studies show that in the special environment of plateau, even though different groups of people, but there is a plateau sleep quality closely affects the mental health problems. In turn, problems such as anxiety and depression seriously affect the sleep quality of the plateau population, thus forming a vicious circle [23].

Studies have shown that the occurrence of hypoxemia during highland sleep is closely related to frequent apnea or hypoventilation, and the hypoxic environment causes a ventilatory response, which results in faster breathing and increased carbon dioxide expulsion leading to hypocapnia, causing respiratory instability and predisposing to respiratory diseases, such as sleep apnea syndrome. Some findings have shown that pulmonary hypertension in Kyrgyz Highlanders is associated with sleep apnea and hypoxemia, which suggests a pathophysiological interaction between pulmonary hemodynamics and sleep apnea [24]. Due to hypoxemia, there is a tendency to have recurrent awakenings during nighttime sleep, which leads to sleep fragmentation [25-27]. During plateau sleep heart rate increases faster and ventilation per minute increases compared to plains, and due to the increased heart rate, resulting in shorter circulation time, chemoreceptors in the body are exposed to blood gas changes more frequently and with increased sensitivity, causing faster respiratory rate and increased ventilation per minute [28]. In a hypoxic environment, periodic breathing can occur during nighttime sleep, a phenomenon that usually occurs above 2000 m in altitude, with individual variability and varying severity. However, periodic breathing occurs in most people above 4000 m altitude [28, 29]. Interestingly, at high altitude, gender may influence the degree of periodic breathing, with men more likely to experience periodic breathing at night at the same altitude [30], and hypoxemia caused by periodic breathing during altitude sleep may be an important determinant of adaptation to high altitude. It has also been suggested that heart rate variability during plateau sleep is associated with periodic breathing [31], resulting in decreased heart rate variability, which is associated with the development of acute mountain sickness.

### 3. THE EFFECT OF PLATEAU ENVIRONMENT ON SLEEP QUALITY

Most of the current research methods for studying subjective sleep quality are Pittsburgh Sleep Index Scale methods, and most studies show that the total score of Pittsburgh Sleep Index Scale increases in a plateau low oxygen environment, and the higher the altitude, the higher the total score [32]. A study on plateau officers and soldiers found that the total PSQI scores of officers and soldiers were higher in the first month of plateau stationing and decreased as the stationing time was extended to 3 months, suggesting an improvement in sleep quality [33]. A study [34] showed that poor sleep quality among officers and soldiers who first entered plateau garrison training was mainly characterized by daytime dysfunction (64.6%), difficulty falling asleep (55.1%), sleep disturbance (54.3%), and poor subjective sleep quality (50.8%). In other words, highland military personnel have poor subjective sleep quality, longer time to fall asleep, reduced sleep efficiency, presence of sleep disorders and daytime dysfunction [35]. Some scholars conducted a survey study of subjective sleep quality in this group of college students using the Pittsburgh Sleep Index scale method, and followed up the analysis with three time points: 7 days, 3 months, and 1 year of residence in the plateau, and found that college students had the best sleep quality when they had lived in the plateau for 1 year [36], which showed that the incidence of sleep disorders was higher in plateau migrant college students than in world residents, and that they had higher sleep quality, sleep The altitude at which the migrant college students are from also affects their sleep quality after migration, and people who live at higher altitudes at a younger age have a stronger ability to adapt to the low oxygen environment of the plateau [37].

At present, polysomnography is commonly used to objectively evaluate sleep quality, and people's sleep structure will change after entering a plateau, especially for those who enter the plateau for the first time. A previous Meta-analysis literature survey of articles related to the effect of plateau on sleep quality over the last decade found that compared with the plains, those who first enter the plateau have reduced total sleep time and sleep efficiency, as evidenced by difficulty falling asleep, frequent awakenings, and the appearance of more superficial sleep

states. Several studies have shown that hypoxia directly affects the structure and quality of sleep in humans, Heinzer et al [38] and Johnson P L et al [39] found that the non-rapid eye movement period increases within one month of initial plateau entry, the reduction of REM phase sleep, and hypoxia causes damage to sleep areas of the brain, resulting in an increase in sleep deprivation and sleep fragmentation sensation. Hoshikawa et al [40] in a study of sleep in athletes acutely exposed to an altitude of 2000 m also showed a decrease in NREM phase. Among healthy climbers, rapid ascent to high altitude initially compromised sleep quality, with climbers experiencing a decrease in sleep efficiency from 93% to 69% and a decrease in NREM stage sleep from 18% to 6% in acute exposure to 4559 m altitude, resulting in altitude sleep disorders [41].

#### 4. PLATEAU SLEEP AND DISEASES

It was found that plateau sleep disorder is an important factor leading to acute plateau disease, and the symptom score of acute plateau disease was significantly negatively correlated with blood oxygen saturation during plateau sleep and significantly positively correlated with hypoventilation index, suggesting a correlation between the level of physiological indicators during plateau sleep and the occurrence of acute plateau disease [42]. It has been reported that the initial changes in plateau pulmonary edema are predominantly interstitial and that reduced sleep quality may be a causal factor in the development of plateau pulmonary edema [43], but further validation is needed. Burgess et al [18] suggested that there is an important relationship between sleep hypoxemia and the development of AMS, and one study showed that increasing blood oxygen saturation during sleep at an altitude of 3800 m can significantly reduce AMS symptoms, i.e., the development of AMS is associated with lower sleep oxygen saturation [44], and therefore monitoring of blood oxygen saturation during sleep is important for the prediction of acute altitude sickness. Some scholars have also investigated the effect of altitude on the sleep and condition of patients with chronic altitude sickness and found that nocturnal hypoxemia caused by reduced sleep quality in highland areas is an important factor in the development of CMS [45]. Some other scholars have suggested that hypoxemia during sleep causes plateau erythropoiesis as a pathological pathway for the development of chronic altitude sickness [46].

In summary, whether it is plateau-based training officers and soldiers, university students or healthy people, plateau hypoxic sleep has an impact on their psychological and physiological aspects. The current research population on plateau sleep is relatively single, and in the future, the sample size should be expanded, different altitudes and different populations should be established for research, and measures should be explored to effectively improve the quality of plateau sleep in order to improve the quality of people's work and life on the plateau.

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