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The Influence of Environmental Index on Sleep Quality

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Abstract. With the changes of the times, people have given different definitions of sleep. After recent years of research, modern medicine generally believes that sleep makes energy storage, which is conducive to the recovery of human's mental and physical strength. Good sleep is not only the basis for the maintenance of health and physical strength, but also the guarantee of a high degree of production capacity. However, in today's society, the problem of insomnia bothers many people. There are many factors affecting insomnia. The purpose of this paper is to study the effect of environmental index on human sleep quality, and to develop devices to improve sleep environment.

Keywords: insomnia, environmental index, air improvement devices

1. Introduction

Sleep is closely related to human health. In today's competitive society, sleep problems are becoming more and more prominent. Word Health Organization shows that about 27% of the world's population suffers from sleep problems, which seriously affects users' health and quality of life. Sleep disorders break various equilibria in the body, which is an important factor leading to cardiovascular diseases and central nervous system lesions.[1]Sleep problems are the result of interaction of many factors, including external environmental factors and internal environmental factors, among which indoor air quality in external environment directly affects sleep quality. This paper explores the effects of ambient temperature, humidity and carbon dioxide concentration on human sleep quality. And through the development of products to improve the sleep environment to help people achieve quality sleep.

2. Literature review

2.1. Research evidence on whether lack of sleep affects human health

In the nurses' Health study, research showed that nurses who slept seven hours a night had the lowest risk of death. The relative mortality risk for sleeping 5 hours or less was 1.15 (95% confidence interval[Cl], 1.02-1.29)for 6 hours, 1.01(95% Cl, 0.94-1.08), for 7 hours,1.00(reference group), for 8 hours, 1.12(95% Cl, 1.05-1.20), and for 9 or more hours 1.42 (95% Cl, 1.27-1.58) [2].

In examining sleep relationships with all-cause and disease-specific mortality in US adults, both short sleep duration and long sleep duration were associated with an increased risk of all-cause mortality over a 5.25-year follow-up period compared with 7 hours of sleep per day. Similar results were observed for cardiovascular and cancer mortality [3].

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2.2. Research evidence on the effect of good natural environment on sleep quality

In our research, the author found that good external natural conditions and sleep environment can improve the quality of sleep. The author looked at a paper published in “Preventive Medicine”. Diana S.Grigsby-Toussaint, a professor of kinesiology and social health in the literature, argues that a better natural environment around people's homes improves their physical and mental health, leading to better sleep quality [4].

In a report on the impact of the environment on the sleep quality of employees in public places, a number of public places were used as experimental objects to analyze the environmental index and environmental excellence number. The report concluded that the better the environmental quality evaluation of public places is, the better the sleep quality of employees is [5].

In a paper on the effect of thermal environment on sleep, it is mentioned that regulating body core temperature and skin temperature by thermal environment has an effect on sleep quality. The quality of sleep is worse in summer than in other seasons, and higher indoor temperature and average radiation temperature in colder seasons can help to sleep [6].

2.3. Research evidence on whether carbon dioxide affects human sleep

In a study on the effect of carbon dioxide on sleep, the single variable method was used to create three conditions of carbon dioxide concentration, and the sleep quality of subjects was observed by questionnaire and victory measures. The final results showed that the sleep quality decreased significantly with the increase of carbon dioxide concentration [7].

Bedroom in a transition season subjective perception and air temperature and co2 concentration in the subject of the relationship between sleep quality and using questionnaire and wrist activity recorded sensor to study, the results show that before sleeping, a little warmer than neutral bedroom environment, and indoor carbon dioxide concentrations lower bedroom, more conducive to people's quality of sleep [8].

3. Objectives and hypotheses

This paper assumes that indoor temperature, humidity, carbon dioxide concentration and other environmental indicators have an impact on human sleep quality. It is based on the research design of a device that can adjust the indoor environmental index.

4. Materials and methods

4.1. Questionnaire survey

First of all, the author adopted the form of questionnaire survey, which was widely distributed in the society, to understood the sleep problems of all ages and the factors that they thought affect their sleep.

A total of 230 people filled in the questionnaire, of which 26.09% were boys and 73.91% were girls. Fig.1 shows that the interviewees were all over 6 years old, and the largest proportion was between 16 and 26 years old. As shown in fig.2, of all the respondents, 20.83% went to bed at 10:00, 25% wen to bed at 11:00, 16.67% at 12:00 and 37.5% after 12:00. Almost all of the participants had experienced insomnia, and 26.09% of them had long-term insomnia. According to the queationnaire surwey, the Fig.3 shows that among the factors affecting sleep, 12.50% of the participants thought it was unhealthy, 29.17% thought it was the pressure of study and work, only 8.33% of the participants thought that the lighting was not suitable, and nearly general participants believed that it was environmental factors that affected the quality of sleep.

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How old are you?

option	subtotal	ratio
6-16	30	12.5%
16-26	120	50%
26-36	10	4.17%
36-46	40	16.67%
Above 46	40	16.67%
Valid fillers	240	

Figure 1. Results from the questions asking age.

What time do you go to bed everyday

option	subtotal	ratio
10 o'clock	50	20.83%
11 o'clock	60	25%
12 o'clock	40	16.67%
After 12 o'clock	90	37.5%
Valid fillers	240	

Figure 2. Results from the questions asking time to sleep.

What do you think are the factors that affect your poor sleep

option	subtotal	ratio
Sick	30	12.5%
Study and work pressure	70	29.17%
lamplight	20	8.33%
Indoor air quality index such as temperature, humidity, carbon dioxide concentrate, etc	120	50%
Valid fillers	240	

Figure 3. Results from the question of sleep influencing factors.

4.2. Data forensics

By consulting the literature of "Human body optimal Environment Index" at home and abroad, as well as Baidu, Quark, Bing and other query platforms, the author drew the following conclusions.

After years of clinical trials and research, experts believe that the indoor high temperature limit is 32 degrees Celsius and the low temperature limit is 15 degrees Celsius in summer, while the indoor low temperature limit is 11 degrees Celsius and the high temperature limit is 21 degrees Celsius in winter. Especially in winter, due to the poor ability of the human body to adapt to high temperature, it can reduce the metabolic function of the human body, resulting in night insomnia, memory loss and other symptoms.[9]

In addition to temperature, humidity is also very important in the family environment. Extremely high humidity will make people tired, emotionally unstable and easily irritable. Too low humidity will lead to dry nostrils and inflammation of the throat, which in turn affects the quality of sleep at night. Medical experts believe that the high limit of indoor relative humidity should be less than 80% and at least greater than 30%. In daily life, the effects of temperature and humidity on the human body always occur at the same time, and can not be acted alone. After long-time tests, experts put forward that the most suitable indoor temperature in summer is 23-28 degrees Celsius and the humidity is 30% -60%; in winter, the most suitable indoor temperature is 18-25 degrees Celsius and the humidity is 30% -80%.[10]

Dutch researchers used high-tech methods to track the nocturnal activities of 17 healthy volunteers for five nights. Some of the participants opened the bedroom door or window while sleeping to make

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the room more ventilated. And some people did not do that. The results showed that in better ventilated rooms, the concentration of carbon dioxide in the air was lower (people naturally exhale carbon dioxide), which was associated with better sleep. The report says lower levels of carbon dioxide in the bedroom mean more sleep, more efficient sleep and fewer wakes.[8]

4.3. Experimental research

The author organized 100 people to participate in the experiment. The author had 25 rooms at 10-15 degrees Celsius, 30% humidity; 25 rooms at 15-20 degrees Celsius and 30% humidity; 25 rooms at 20-25 degrees Celsius and 30% humidity; 25 rooms at 25-30 degrees Celsius and 30% humidity. 100 rooms tested for the same concentration of carbon dioxide. Volunteers who took part in the trial were asked to enter a prepared room and sleep on a bed used testing. Participants' sleep status was measured by visual cameras that observed how long they slept, how many times they turned over and how loudly they snore. Participants slept better in rooms with the same humidity and carbon dioxide levels at 15-20 degrees Celsius and 20-25 degrees Celsius.

The participants did not change. The author prepared the same room again, the same room temperature and the same carbon dioxide concentration. Took 25 rooms as a unit, set 4 different humidity, respectively 10%, 30%, 50% and 70%. Sleep status was measured by how long the participants slept, how long they woke up, how many times they turned over and how loudly they snored. Studies showed that in the same indoor temperature and carbon dioxide concentration under the circumstances, the room humidity in 30%-50% was the most suitable for human sleep.

One hundred participants did not change. The author set the room to the same temperature and humidity, 50 rooms had Windows open for ventilation, 50 rooms had Windows closed. Participants' sleep status was measured by observing how long they slept, woke up, turned over and snored. In studies, participants who kept their Windows open slept better and woke up less in the night.

5. Development of the device

This product is divided into two systems, namely, environmental monitoring system and sleep monitoring system. The environmental monitoring system includes indoor air temperature and humidity control system, temperature query and record data module. The sleep monitoring system includes visual monitors, sleep pillows and mobile apps.

5.1. Environmental monitoring system

The environmental monitoring system collects indoor air temperature, humidity, carbon dioxide concentration and other data and uplots them to the middle end of the intelligent control system for algorithm processing, and the intelligent assistant makes suggestions on air quality regulation suitable for sleep, and transmits them to the temperature and humidity regulating device. The device automatically sets the parameters, automatically adjusts the optimum temperature, humidity and oxygen content through the regulator. It also greatly reduces the system cost, provides convenient, intelligent, accurate service, which becomes the user's intelligent housekeeper.

5.2. Sleep monitoring system

The visual monitor monitors sleep time, roll over times, wake up times at night and snoring. The pressure pillow can set the most suitable position for the user through the pressure sensor. If the sleeping position affects the neck health, the pillow will alert the mini program in time, and use its own intelligent control device to improve the pressure balance of the pillow, so as to improve the user's sleeping position and reduce the neck pressure of the user. The sleep pillow adds a heart rate monitor to the user's carotid artery to monitor the user's heart rate and blood flow to the neck during the night. On the one hand, it can accurately judge the user's sleep time and sleep quality; On the other hand, the daily continuous monitoring of heart rate is very likely to find health problems. Once abnormalities are found, users are advised to have a physical examination in a timely manner in the mini-program to ensure their health.

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5.3. Easy to view the App

By click on the APP to open the home page of the system, users can see the home page, sleep, discover, my and other operations of the system on this interface. Users can click on sleep headlines, training videos, sleep diaries, medication records and other functions to open the corresponding function interface, which can be seen in Fig. 4.

Clicking on the function button of Sleep Headlines in the home page of the system to open the interface of sleep Headlines. On this interface, users can see detailed information from sleep headlines to help them get a better night's sleep, which can be seen in Fig.5.

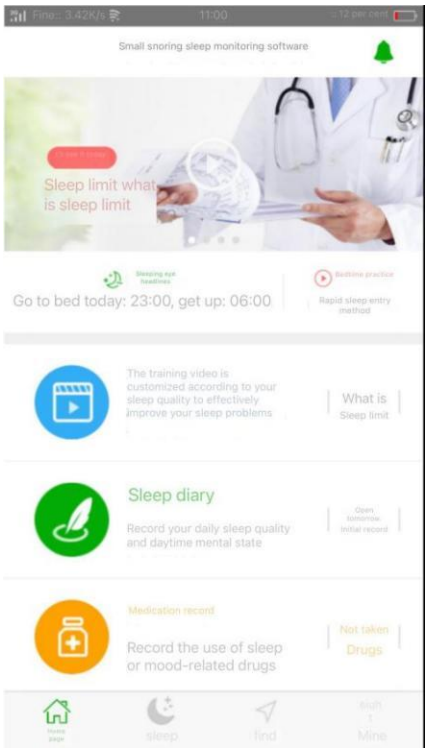

Figure 4. Home page of the APP.

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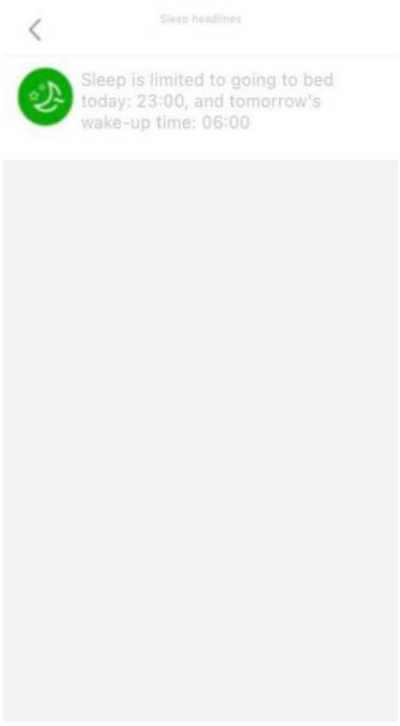

Figure 5. Interface of sleep headlines.

By clicking on the sleep diary function button in the home screen of the system, the interface of sleep diary can be opened. On this interface, the user can see the information of sleep diary, and the user can view the corresponding sleep diary by date.

Clicking the line chart button in the sleep diary can open the sleep statistics screen. On this interface, users can see the information of sleep efficiency, sleep time, sleep time, early awakening and night awakening in the sleep statistics. Users can click an item to view the corresponding information.

Clicking my function button in the system interface can open my interface. On this interface, users can see my sleep files, my cases and other functions. Users can click a job to open the corresponding functional interface.

Clicking my Sleep Profile function button in my interface can open my sleep profile interface. On the interface, users can see written quality, anxiety and depression in their sleep profiles. Users can carry out sleep quality assessment questionnaire analysis, sleep diary and other functions on this interface. Detailed functional operations are shown in Fig.6:

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Figure 6. Interface of sleep profile.

The mobile phone app records the daily indoor environment index and the sleep quality and health status of users, generates a sleep health report every month, analyzes the data, sets the most suitable temperature, humidity and oxygen content for users, and adjusts the environmental parameters in time, make suggestions for users' work and rest time, and consequently realize the private customization of sleep to ensure the sleep quality and health of each user.

6. Anticipated outcome and value of the research

By improving the environmental index of the equipment, it can greatly maintain the human body's optimal environmental temperature, humidity and carbon dioxide concentration, and finally improves people's sleep quality to a large extent.

7. Conclusion

The topic of this paper is the influence of indoor environmental index on human sleep quality. The author drew a conclusion from the way of questionnaire analysis, literature collection and practical investigation. Indoor temperature, humidity and carbon dioxide concentration all affect the quality of sleep. And based on the experimental results, the author have made a device that can improve the air index and sleep quality, so that people in society can achieve high-quality sleep.

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