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Research on healthy human sleep circadian rhythms

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Abstract. The exhaustion of humans during the day is the primary motivation for this paper. Circadian Rhythm is a necessary system, which is the 24-hour cycle that is part of humans' inner clock that controls and organizes the essential functions and processes in our body. A significant example of circadian rhythms is the cycle of sleep-wake. Sleep is an inalienable part of human life (humans will die for sure if they stay awake for 10 years). However, the length of sleep will decrease based on human's age. The older human is, the less sleep they will require. However, circadian rhythm can greatly impact dietary intake and physical activities and is fundamentally impacted by brightness and sleep-inducing substances. And this paper will introduce how to scientifically set up the circadian rhythm, and how to maintain a healthy circadian rhythm by utilizing those 4 main factors. So that reduces the exhaustion for humans dyscalculia from the circadian rhythms; and implies a healthy, positive, and efficient society. And the goal for this paper is that advising human maintain a consistently daily life which can greatly reduce exhaustion.

Keywords: circadian rhythms, sleep, brightness, time, exhaustion.

1. Introduction

Exhaustion is an unalienable human emotion or feeling. Being exhausted is a negative feeling. Especially in the early morning, a decent amount of people still constantly feel drowsy during work for example, less effiency on finishing daily routine, and causing healthy conditions such as insomnia, endocrine dyspraxia…(Eng Min J 2018 Feb; 219(2):38-40); the majority of students are sleepy during class (Harms M. Individual differences in tolerance to shift work: a review. Ergonomics. 1993;36(1-3):101-9.). Phenomenon above demonstrate the study of sleep is mandatory since the unhealthy circadian rhythms will disrupt our daily life or even directly impact our health. Therefore, the purpose of this paper is to explore a certain way to help the majority of people reduce their exhaustion in real life and increase their length of wakefulness. As a result, sleep and circadian rhythms pop up immediately. Humans spend one third of their lives sleeping; however, is their sleep ideal and useful? which leads to today's core and centripetal question: "What is the scientific way to set up the circadian rhythm so that it keeps humans awake and fulfilled with energy as much as possible". A better circadian rhythm not only reduces exhaustion and increases wakefulness, but also promotes a healthier daily routine and Hormone release. Therefore, this paper investigates the method of setting a scientific circadian rhythm. This research contributes to human health and the normal operation of society.

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2. Analysis of setting scientific circadian rhythms

First, this section will present the ideal time for sleeping depending on age and health conditions.

Table 1. the ideal sleeping hour for ages of people.

Age	Average time for sleeping (hrs per day)
Newborn babies (0-3 months)	14-17
Infants (4-11 months)	12-15
Toddlers (1-2 years)	11-14
Preschoolers (3-4 years)	10-13
School-age children (5-12 years)	9-11
Teenagers (13-17 years)	8-10
Adults (18-64 years)	7-9
Elder (over 65 years)	7-8

An overall pattern is that older people require less time to sleep [1]. Since children's bodies require more hours of sleep to develop and function properly [2]. The advantages of sleep can be summarized as: restoration (remove metabolic end products that damage and inhibit their brain's foundation function); memory processing (SWS associated with hippocampal replays encoded neural patterns that consolidate humans declarative memory), and Dreaming (irrelevant but exists) [3, 4]. Besides the length of sleep, the quality of sleep is also an unalienable section. Sleep quality is based on how hard it is for a person to fall asleep and remain asleep, as well as how many times they wake up during a night. There is no certain relationship between quality and quantity of sleep. There is no possible way to replace the lack of sleep quantity with the quality of sleep, and vice versa. The Sleep Need Index, also known as SNI, was applied to self-check whether one needed more sleep or not. The formula: sleepiness/sleep duration is calculated as a number range, taking SNI value 0.26 as the judgment value; if it is above 0.26, then people definitely need more sleep, and vice versa [5].

The circadian rhythm is the 24-hour cycle that is part of the body's internal clock that runs in the background to carry out essential functions and processes. One of the most important and well-known circadian rhythms is the sleep-wake cycle. The circadian rhythm fundamentally depends on hormonal signals from the hypothalamus or process C and S, as well as the brightness captured by the suprachiasmatic nucleus, known as SCN, a brain area directly above the optic chiasm [6]. Brightness greatly impacts circadian rhythm since brightness is the main signal of what time it is. If the SCN doesn't detect light, the pineal gland is free and automatically produces melatonin, which is a type of sleep-inducing substance that will make humans feel drowsy. For instance, exposure to light during the night can suppress melatonin secretion, and increase wakefulness [7,8]. While a precise 24-hour circadian rhythm is found in most organisms, it isn't universal or unique; organisms living in the high arctic or high antarctic don't experiment with daytime all year, which generally maintain certain circadian rhythms that close to 24 hours, such as the penguins and polar bears whose lives are in the south pole and north pole [9]. Although there are still a decent amount of organisms that reside in the dark biosphere, and these may exhibit rhythmic physiology, the dominant rhythm is not going to be circadian. Therefore, brightness has a huge impact and is an important tool for scientifically resetting the circadian rhythm. In short, sleep-wake Homeostasis, also known as Process S, is the accumulation of sleep-inducing substances in the human body. In simple terms, the longer people stay awake, the more those sleep-inducing substances will accumulate in the brain. The amount of sleep-inducing substances directly impacts wakefulness in humans (possibly as a potential way to impact circadian rhythms by controlling

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the production of sleep-inducing substances). One neurochemical indicator of a sleep-inducing substance is adenosine, which will under-stimulate body function and sensitivity [10].

Besides those scientific and fancy techniques, there are still other factors that can greatly impact humans' circadian rhythms. Dietary intake and physical activity also impact circadian rhythm. Food is one of the external synchronizers of the human peripheral clock, which has the same concept as brightness: the primary role of circadian rhythm is to entrain the organism to environmental cues. Therefore the anticipation of food availability and food choice can influence the judgment of circadian rhythm. There is no doubt that limiting dietary intake at certain times during the day will not fundamentally but greatly impact behavior and physiology, which indirectly impact the circadian rhythm [11]. Physical activity or exercise induces physiological changes, such as body temperature and hormonal signaling, that affect peripheral circadian clocks through sympathetic activation and glucocorticoid release. For instance, the elevation of body core temperature will cause a higher heart rate and become an input to the circadian pacemaker gradually impacting circadian rhythms [12].

Now back to the original topic of this paper, start with the interference of light and brightness. Based on the intervention of a cycled light system in the ICU room, which simulates the real world for supporting patients' circadian rhythms, a result that most satisfies the circadian rhythms. Most patients reported that their sleep was worse in the ICU with intervention than at home. This makes sense because as mentioned before circadian rhythms are extremely dependent on people. However, the conclusion that can be drawn is that as long as people follow natural circadian rhythms and consist of them, therefore they will end up with a decent circadian rhythm [13].

Table 2. An intervention room that artificially for acting as a natural world. The illumination levels are based on time.

Light scenes in the intervention room	Time	Illumination levels in lux in horizontal plane
1	7-8 am	58
2	8-10 am	615
3	10-10:30 am	450
4	10:30 am - 1 pm	330
5	1-3 pm	210
6	3-5 pm	450
7	5-6 pm	330
8	6-7 pm	210
9	7-8 pm	81
10	8-8:45 pm	58
11	8:45-9 pm	30
12	9-9:15 pm	12
13	9:15-9:30 pm	8
14	9:30 pm- 7 am	2

As usual, as long as humans are in tune with their circadian rhythms, they don't need to worry about homeostasis. Because there is indeed a balance between the production and accumulation of sleep-

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inducing substances and the destruction of sleep-inducing substances. Dietary intake can greatly affect circadian rhythms due to the different nutritional compositions and timing of meals in humans. Therefore, it is necessary to formulate a healthy diet according to the specific conditions unique to each individual, so as to ensure a healthy sleep rhythm. For example, substances such as caffeine, alcohol, or melatonin can significantly affect circadian rhythms. This article recommends careful consumption and never becoming addicted to any of these foods. It would be better if the meal time was consistent so that the body could form its own work and rest habits and adapt. Also, exercising is another good habit that is beneficial to human circadian rhythms. Therefore, this article suggests that people can do high-intensity exercise and vigorous exercise in the morning and low-intensity exercise in the evening. High-intensity exercise increases heart rate and body temperature and, most importantly, delays melatonin production. This helps humans stay awake during the day.

3. Conclusion

There is indeed a more general way of helping humans reduce exhaustion, and increase their efficiency as a whole. As a result, there are four main factors: dietary intake, activity, brightness, and sleep-inducing substances, which tremendously impact circadian rhythms. However, this paper is originally for humans as a whole instead of a certain group of people, which makes that too vague to actually "rescue" and "reduce exhaustion". In the future, it is hoped that future studies can expand the scope of the study, which can provide more detailed and reliable results. For example, hire testers and a controlled experiment was conducted; separated into three levels of intake groups: over intake, less intake, and normal intake. So that comparing data and ANOVA which will provide us result. As well as utilize animals experiment such as mice; the advantages of animal experiment are easier and more flexible for controlling and processing the experiment; and exploring more factors which provides a more specific and accurate result.

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