

## EDUCATIONAL RECOMMENDATIONS TO MAINTAIN A HEALTHY BIORHYTHM OF CHILDREN LIVING IN A LIGHT-POLLUTED ENVIRONMENT

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### Abstract

Some of the children who grew up in an urbanized environment may have never been able to look at a clear, starry sky. Experiencing the natural darkness of the night, which has been an essential part of humans' life, is now a privilege for fewer and fewer people. Lack of this natural connection can result in a shift in human biorhythm, which can also lead to health problems such as sleep disorders. The focus of this poster presentation, is the relationship between the geographical spread of light pollution and the appearance of human biorhythm problems in Europe using quantitative data from previous research (e.t. SHARE 2010/2011; VIIRS 2013). In light of this, educational suggestions are made to help a healthy biorhythm of those children that are exposed to light pollution. These suggestions are developed by examining not only yoga culture and traditional Chinese medicine (e.t. Bell, 1981; Bhattacharya, 2015) but also traditional Hungarian peasant life (e.t. Oláh, 1986). The novelty of the research topic is that the target groups of biorhythm education proposals have been identified by geographic analysis of light pollution (and biorhythm shift). In addition, less well-known school-based methods for maintaining an appropriate biorhythm are also presented.

Keywords: light pollution, biorhythm, environmental education, yoga culture, Chinese medicine, Hungarian culture, health education

### Introduction

Education has a key role to play in shaping ideal biorhythms at any age, but methods have so far been unable to keep up with the accelerated technological and energetic development and urbanization processes. The first part of the study presents the possible relationship between light pollution and sleep disorders on the European continent. The second unit presents practices from Ayurveda, Traditional Chinese Medicine and traditional Hungarian peasant life, all applicable in a school setting, in order to adequately regulate biorhythms for children living in urban areas. The aim of the study is to raise awareness of the risks of light pollution and to establish an adaptation to these risks in education.

### The patterns of light pollution in Europe

According to the VIIRS 2019 survey (see: Figure 1), it can be concluded that the pattern of light pollution on the European continent is diverse. Higher light pollution values typically appear in highly urbanized areas. The radiant density of the pixels is remarkably high in the triangle enclosed by Arras - Dortmund - Amsterdam, in the central and southern parts of the United Kingdom, in northern Italy, and in and around capitals and big cities. If we examine the level of light pollution per 1000 inhabitants in each country, it can be concluded that the population of Northern Europe, mainly that of Iceland, Finland, Norway, Estonia and Sweden, is the most exposed to light pollution. Among the least light-polluted countries are Moldova, Germany, Switzerland, Ukraine and Romania.



*VIIRS 2019 light pollution map of the European continent  
(not including all European territories) (1.)*

### The connection between light pollution and sleep disorders in Europe

Comparison of the data (see: table) using the two-sample t-test showed that at a significance level of 1%, there is a significant difference between the prevalence of sleep disorders in countries with above-average (mean of prevalence of sleep disorders: 21%) and below-average (mean of prevalence of sleep disorders: 27,4%) EU living standards. Based on the correlation analysis, there is low correlation between the intensity of light pollution and the prevalence of sleep disorder, with the correlation coefficient being 0.269, while there is a perceptible relationship between living standards and the prevalence of sleep disorders with the correlation coefficient being -0,728. Based on this finding, living standards are likely to have a greater impact on sleep disorders than light pollution. According to the table, it can be concluded that sleep disorders are most at risk in countries which, in addition to low standards of living, are associated with a higher level of light pollution. Prime examples of this are Estonia, being the most light polluted, Poland and Portugal, which all have lower standards of living with outstanding levels of light pollution and have the highest prevalence of all the 16 countries.

### Conclusion

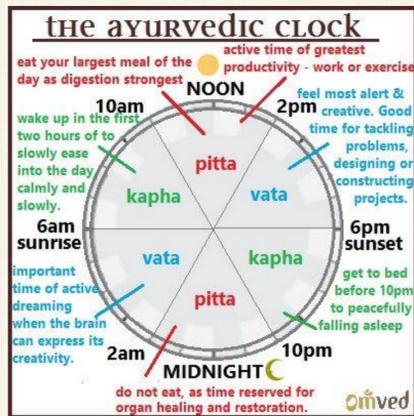
**We can conclude that in the case of European countries with a lower standard of living special attention should be paid to educational activities aimed at maintaining adequate biorhythms. Areas with lower living standards and high light pollution levels are the most vulnerable, in the case of which an even greater emphasis must be put on pedagogical work.**

Country	Standard of living (GDP/capita, PPS)	Intensity of light pollution ( $10^{-9}$ W/cm <sup>2</sup> x sr)/1000 capita	Prevalence of sleep disorders (%)
Switzerland	163	41,7	17,4
The Netherlands	135	118,2	16,8
Denmark	129	78,7	16,6
Austria	129	50,2	20,5
Sweden	127	265	19
Germany	124	48,3	26,7
Belgium	120	122,8	27
France	109	98,5	28
Italy	104	89,9	16,6
Spain	93	102,4	24,3
Czech Republic	84	70,1	25
Slovenia	84	60,9	22,7
Portugal	78	118,4	29,8
Estonia	71	449,1	30,5
Hungary	66	59,6	28,1
Poland	66	119,5	31,2

*The standard of living in some European counties (GDP/capita in PPS, based on Eurostat 2011), intensity of light pollution per 1000 capita (based on the radiant density of the pixels in the VIIRS 2013 survey), the prevalence of sleep disorders in the population aged 50 and over (based on SHARE 2010/2011).*

## Educational recommendations for the regulation of adequate biorhythms

In order to adapt to light pollution, it is worth studying the teachings of the pre-modern world related to maintaining adequate biorhythms, comparing them with modern research and, where appropriate, incorporating them into pedagogical work. In the case of the geographical areas highlighted in the previous unit it is important to raise awareness of this new approach, to which the study of Traditional Chinese Medicine, Ayurveda and traditional Hungarian peasant life can provide notable help.



Ayurvedic clock (2.)



István Csók: Gathering Hay (1890) (3.)



Chinese yin-yang symbol (4.)

According to Bell (1981), the idea of a biological clock, the cornerstone of Traditional Chinese Medicine, coincides with laboratory research on the circadian rhythm in the Western world. The circadian rhythm is substantially determined by the changes in melatonin hormone levels generated by the day and night cycle. By influencing this process, light pollution can disturb our natural biorhythms, for the prevention or treatment of which excellent examples can be found in Traditional Chinese Medicine. Thousands of years of doctrine have put an emphasis on the importance of harmony and balance, also represented by the yin and yang symbol in Figure 4, a knowledge that is, not unreasonably, also called for in the modern western world. In addition, some important principles can be found in Ayurveda, where daily biological rhythms are coordinated by an Ayurvedic clock that bear resemblance to the Chinese system (see: Figure 2). A similar system of views is represented in the traditional Hungarian peasant culture by the definition called "natural sleep", which constituted sleep that was in sync with natural cosmobiological rhythms (Oláh, 1982). In the following, some relevant elements of the three medical trends above are presented. The descriptions aim at shaping students' adequate biorhythms, especially of those living in the areas described in the previous unit, and can be incorporated into both theoretical and practical education.

An essential element of maintaining our ideal biorhythms is the process of waking up in the morning. Ayurveda suggests a **slow, gradual rise**, with attunement to the day (Bhattacharya, 2015). **The morning period is excellent for sports, handling stress, which can be further facilitated by yoga exercises** (Rao and Kumar, 2019). Yoga education is included in the grade 5-12 PE Framework Curricula related to 2020 Hungarian National Core Curriculum. According to Traditional Chinese Medicine, **tai chi practices** including certain breathing exercises, both equally being meditative forms of movement, are favourable in the morning (Bell, 1981). The benefits of aerobic morning exercises for students' psychological well-being were also demonstrated by Barbar (2012). According to Ayurveda, it is from 10 am to 2 pm that we are most productive and that is the period when we are supposed to do work requiring outstanding mental strength and endurance and is best if prepared for with morning exercises (Rao and Kumar, 2019).

Children's meals should also be aligned with their biological clocks, a hearty hot breakfast and lunch are especially important. In Ayurveda, meals are an opportunity for self-healing and maintaining health. The

principle of **"eating when we are really hungry"** also plays an important role in Ayurveda (see: Rao and Kumar, 2019) and in traditional Hungarian peasant culture (see: Oláh, 1982). This involves **allowing ample time for digestion** between meals and before bedtime, which can be supported, for example, by an easy walk after a meal. It is important to **eat food slowly and consciously, based on a variety of local ingredients**, excluding TV and smartphones while eating, avoiding fast food restaurants and being aware of the food consumed (Rao and Kumar, 2019). **Proper eating habits can also be taught at school, complemented by botanical and horticultural education, as well as cooking skills.**

Following the principles of Ayurveda, Bhattacharya (2015) recommends **spending time in nature on a daily basis**, which is also in line with the teachings of Traditional Chinese Medicine. The recreational effects of nature have also been supported by western researches, including Kaplan and Kaplan's (1989) "Reshaping Theory of Attention". According to Csonka and Varga (2019), free time spent in nature is also of paramount importance, not only for the preservation of well-being, but also for the development of ecological identity.

According to Ayurveda, the pre-bedtime period is key to maintaining adequate biorhythms. It is not recommended to go to bed earlier than three hours past dinner time. During this period **the use of electronic devices causing light pollution should be avoided**, and children should spend time reading, talking, relaxing, and playing (Rao and Kumar, 2019). **During sleep at night commonly recommended from about 10 pm. it is important to create a light-free environment** (Bhattacharya, 2015).

The **"natural sleep"** characteristic of traditional Hungarian peasant life, and of cultures before modern era in general, constitutes the adaptation to our sleep requirements arising from our natural environment in response to light and heat, for example, as seen on the painting depicting resting peasants gathering hay by István Csók in picture No. 3. As a result of moving away from this concept, artificial environmental effects are thought to lead to sleep problems. Gandhi et al. (2015) also pointed out that **adaptation to our sleep requirements arising from our natural environment can help alleviate sleep disorders of the modern world.** This may involve some kind of adaptation to, for example, natural light and temperature conditions or seasons.

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### Link of the photos:

1. [www.lightpollutionmap.info](http://www.lightpollutionmap.info), 2. <https://i.pinimg.com/originals/bc/8f/2e/bc8f2ebb74a645a90b6739a1b6736c9b.jpg>, 3. <https://www.hung-art.hu/tajkepek/szenagyu.jpg>, 4. <https://www.logodesignlove.com/yin-yang-symbol>

### Note

*The content of this poster is partly a translation of the poster titled "The Shadow of Artificial Light - Educational Recommendations to Maintain Adequate Biorhythms for Urban Children" published in Hungarian at the 2020 HuCER Conference.*

### Acknowledgement

*This publication was supported by the EFOP-3.6.2-16- 2017-00014: "Developing an international research environment in the field of light pollution testing" project.*