EVENING CHRONOTYPE AS A RISK FACTOR FOR UNHEALTHY BEHAVIOR AND SOCIAL JETLAG

Summary. Preference for later bedtimes and rise times characterize evening chronotypes. Evening chronotypes suffer from early work start times thereby contradicting their circadian rhythms, as a result, a late wake-up time on free days reflect an attempt to compensate for a sleep debt accumulated on work days. This leads to a misalignment in sleep timing between weekdays and weekends, known as social jetlag (SJL), which is associated with increased health risk. Here we analyze the risks that evening preferences related with SJL bear and their potential impact on health, and also talk about possible correction measures, primarily of a behavioral nature, using literature data from PubMed and Embase database. Evening chronotype can compromise the maintenance of a healthy lifestyle. Evening chronotypes are more prone to bedtime screen use, which can suppress melatonin rise and extend wakefulness activities far into the night, thus dragging sleep and meal timing to later periods. Preference towards later time-of-day is linked with higher intake of total calories and fats, as well as unhealthy dietary habits (breakfast skipping, snacking, longer eating duration). Evening chronotype also has been associated with high caffeinated drinks intake, alcohol consumption and smoking, low physical activities. It has been found that unhealthy behavior might function as the promoting factors to circadian misalignment and greater SJL. Interventions to prevent and control unhealthy behaviors among evening types should be included in preventive measures of SJL.

Keywords: evening chronotype, social jetlag, unhealthy behavior, health risk, preventive strategies.
Selection of previously unsolved parts of the overall problem. There is broad consensus that personal behavior patterns or lifestyle are among the most important modifiable causes of health. Hence, interventions to prevent and control unhealthy behaviors among evening types may lessen the harmful effect of SJL.

The purpose of the article was to analyze the risks that evening preferences related with SJL bear and their potential impact on health, and also talk about possible intervention measures, primarily of a behavioral nature. Articles were found by searching at PubMed and Embase with the search words “evening chronotype”, “social jet-lag”, “unhealthy behaviors”, “health risk”, “prevention strategies”. We also checked the references of all relevant studies and review articles to identify additional sources. We discuss lifestyle-related factors (light-emitting screen use, diet habits, caffeine-ated drinks consumption, alcohol use and smoking, physical activity level) as behavior which can be an additional cause of various health problems of SJL. Preventing main material. This study found that many people categorized as evening types experience deleterious health behaviors, thereby rendering them more vulnerable to circadian misalignment.

In the first place, evening preference is associated with disproportional evening exposure to artificial light sources and lack of morning light exposure [7, p. 92].

Increasing artificial bright light in evening can shift the biological clock to a later phase and thus increase SJL. Study by Vollmer C. et al. [8, p. 503] has reported that adolescents living in brightly illuminated urban districts had a stronger evening-type orientation than adolescents living in darker and more rural municipalities.

The negative effects of exposure to nocturnal light on human beings are well established. Exposure to light in the evening and early part of the night, even at low intensity, suppresses the release of the sleep-facilitating hormone melatonin and shifts the circadian clock to a later time, both of which make it more difficult to fall asleep at night [7, p. 92]. Furthermore, melatonin inhibition by artificial light at night results in the loss of the multiple other biological effects of the hormone.

Study Giuntella O., Mazzonna F., 2019 [9, p. 215] found that an extra hour of natural light in the evening reduces sleep duration by an average of 19 minutes and increases the likelihood of reporting insufficient sleep. Inhibition of nocturnal secretion of melatonin, sleep deprivation, and clock disruption are three of the multiple mechanisms of action put forward to explain the deleterious effects of artificial light at night, and they are considered to be of primary importance [5, p. 279]. In addition, individuals with evening preference have been shown to be even more sensitive to evening light than earlier chronotypes [2, p. 1080].

Evening types were reported to have reduced sleep quality and shorter sleep duration. Sleep becomes irregular, shortened and delayed in relation with later sleep onset and early waking time which results in complaints of both insomnia and hypersomnia. Sleep debt accumulates more quickly in women than men, and has a greater negative impact on women’s health [8, p. 504].

Sleep health increasingly is viewed as a crucial determinant of physical and psychosocial health and well-being. Sleep is a state of altered metabolism, and that disturbances and curtailing of sleep have far-reaching effects on endocrinology, immunology and metabolism, changes that may be linked to disease [2, p. 1082]. Short sleep duration could develop into sleep disorders in severe condition, and this condition means that an individual’s immune function will decrease and levels of inflammation increase. An adverse impact of experimental sleep restriction on insulin resistance, leading to reduced glucose tolerance and increased diabetes risk, has been well-documented [10, p. 201].

Light at night has been also proposed as a risk factor for breast cancer by Stevens et al., 2014 [5, p. 210]. According to several studies [2, p. 1080; 11, p. 135], hormone melatonin suppression by exposure to light at night, disruption of the immune system caused by sleep deprivation, and repeated circadian misalignment are the possible multiple and interconnected cancer-promoting mechanisms, especially breast and colorectal cancer.

Shift workers are a group of people that is highly affected by circadian disruption, with a considerable influence of work times on biological sleep timing [11, p. 133].

People taking longer daytime naps to compensate for sleep deprivation suffer from insufficient nocturnal sleep and reduce sleep quality. Furthermore, the long daytime naps are thought associated with other health problems such as diabetes or cardiovascular diseases [12, p. 380]. Only a short daytime nap (less than 30 minutes) are helpful for reducing daily sleep debt and counteracting SJL [13, p. 13482].

Animal models have shown that artificial light at night can also induce depressive-like behavior, and this direct link between light and mood is mediated by intrinsically photosensitive retinal ganglion cells. Those photosensitive retinal ganglion cells are a constituent part of the retino-hypothalamic pathway that provides the suprachiasmatic nucleus of the brain with information on environmental light exposure levels, and that together with rods and cones, determine the biological effects of light.

Indeed, the association between light and mood is well established, and morning bright light exposure is a highly effective therapeutic approach in depression and mood disorders. In a recent, prospective study, Obayashi, Saeki, and Kurumatani, 2018 [3, p. 428] reported that individuals who sleep in bedrooms that are brighter than 5lux at night are at higher risk for depression as compared to those sleeping in darker bedrooms.

Artificial light at night is therefore likely to induce further misalignment between environmental or behavior cycles and physiology, or exacerbate disruption.

There is a growing body of evidence that evening type is related to electronic devices use in bed before sleep, as well as to internet addiction which can extend wakefulness activities far into the night, at that girls are more prone to smartphone addiction [14, p. 465].

There is a lot of evidence that LED screens emit much more blue light with a peak at 452 nm than white incandescent bulbs and compact fluorescent
less weight and displayed a slower weight-loss rate of metabolic control and weight-loss therapy.

Morning types 

Participants reading an LE-eBook took longer to fall asleep and had reduced evening sleepiness, reduced pineal melatonin secretion, later timing of their circadian clock, and reduced next-morning alertness than when reading a printed book. This study supports the finding that especially the light emitted from electronic devices shifts people to eveninness.

Orangetinted blue light-blocker glasses can be used to counter light effects because they filter out the short wavelengths in the blue range portion of the spectrum. The results of study van der Lely et al., 2015 [18, p. 115] demonstrate that blue blocker glasses attenuate melatonin suppression induced by a nocturnal light pulse.

Although light is a strong modulator of the neural circadian clock, time of food intake is emerging as a dominant agent that affects circadian clocks in metabolic organs.

The evening chronotype may potentially modify eating time, dragging it to later periods [10, p. 201]. The meal timing results revealed that individuals with evening preference ate their breakfast, early afternoon snack and dinner at later times. Furthermore, evening types reported a longer eating duration, which may suggest a greater availability of time to eat.

Evening types consume a large amount of high-energy food and beverages than morning types. Several authors have suggested that this eating behavior is a consequence of decreased levels of satiety hormones (leptin and ghrelin) which may decrease satiety and increase appetite, favoring weight gain in situations of circadian misalignment. [19, p. 132] These mechanisms help us to understand why individuals with social jetlag also reported higher consumption of total calories, proteins, total fat, saturated fat and cholesterol, and in particular, higher calorie consumption after 9 p.m., than those without social jetlag [20, p. 0212126].

Among other unhealthy habits, it has been observed that individuals with evening preference often skipped breakfast [23, p. 359]. A cross-sectional study conducted with Brazilian undergraduate students pointed out that social jet lag was higher in evening-type subjects and the frequency of breakfast skipping within these participants was high. Of note, that the habit of eating breakfast is currently considered an important indicator of health, and that overweight or obesity have been highly associated with breakfast skipping. The risk of obesity in children and adolescents who skipped breakfast was 43% greater than those who ate breakfast regularly [22, p. 4]. The regular breakfast consumption is also potentially important for the prevention of type 2 diabetes [1, p. 1597; 21, p. 60].

Eating at a later time could influence the success of metabolic control weight-loss therapy. It was showed that late lunch eaters (≥15b) lost less weight and displayed a slower weight-loss rate during the 20 weeks of treatment than early lunch eaters [1, p. 1597; 24, p. 3695].

Eating during the usual sleeping period is an example of circadian misalignment, and is related to adverse metabolic outcomes [19, p. 132]. The results of studies demonstrate that living against the internal clock is contributing to the epidemic of obesity in industrialized societies, and improving the synchrony between the social and biological clocks may be one of the approaches for fighting obesity [25, p. 69]. Another study has reported that evening types have a significantly greater body mass index compared with morning types. In addition, it has been reported that evening preference is independently associated with lack of control of glucose in type 2 diabetes [21, p. 61]. Considering the intricate relationship between circadian rhythms and metabolism, it is not surprising that chronic disruption of circadian rhythms is associated with the development of metabolic syndrome, which may lead to cardiovascular diseases and diabetes [1, p. 1597; 20, p. 0212126].

Taking into account the aforementioned, Zezula-Rugieri MF et al., 2019 [26, p. 2980] recently proposed a new marker of the variability in meal timing, which, due to its resemblance to social jet lag, they have denominated ‘eating jetlag’. Eating jetlag was associated with higher Body Mass Index, development of obesity and less weight loss in response to weight loss therapy.

It is thus possible that eating during habitual sleep times may occur as a consequence or perpetuation of SJL and warrants future studies to consider the effects of both disrupted sleep and mealtime rhythms.

Since most morning schedules can be a burden for evening types, they needed more stimulants, such as caffeine and caffeinated drinks to compensate for their daytime sleepiness. Available data suggest that individuals with evening preference may increase their addiction opportunity to these drinks, which can contribute to an increase in sugar intake and may influence weight gain. For example, a study by Zhang et al., 2018 [13, p. 13482] revealed a significant mediated effect of caffeinated drinks consumption and which played a positive role in linking evening chronotypes and increased body mass index among medical students at Chinese University.

In turn, caffeine consumption could add to their existing sleeping difficulties in individuals with evening preference, especially in young adults, contributing to shorter sleep duration and wake time after sleep onset [27, p. 228].

The caffeinated drinks consumption only belongs to one kind of stimulation; other substances, such as tobacco and alcohol, have also been reported to be positively associated with evening chronotype.

According to the authors Hug E et al., 2019 [28, p. 127], the evening chronotype and poor sleep may contribute to alcohol use, as well as a greater discrepancy between weekday and weekend bedtimes was associated with increased alcohol use. Specifically, short sleep duration and mistiming of the sleep period both had particularly deleterious effects on adolescent functioning which led to increased risk of alcohol use.

There are arguments for bidirectional prospective associations between inadequate sleep and
alcohol use [29, p. 202]. Inadequate sleep may contribute to alcohol use through impairments in emotion regulation or cognitive functioning. Conversely, alcohol use may lead to inadequate sleep through the biological effects of alcohol or social influences. Moreover, alcohol by itself is able to desynchronize the circadian systems by lower levels of melatonin or alterations in circadian rhythm of body temperature.

The smoking prevalence among evening types was higher than among morning types [30, p.763]. The fatigue resulting from sleep difficulties and poor sleep quality might also stimulate smoking. Remarkably, tobacco smoke interfere with cytochrome P450(CYP)1A2 (CYP1A2) metabolism thus effecting endogenous and exogenous melatonin levels [31, p. 180].

Evening types may lose considerable time for exercise and activities. This has been confirmed in a recent study that showed that sleep debt was correlated with a low physical exercise time and was associated with low physical activity in night workers [32, p. 86]. A high level of fatigue and increased daytime sleepiness of evening types contribute to a shorter physical activity and increased time in sedentary states [33, p. 720].

Since decreased level of activity is one of the known risk factors for obesity, these data are compatible with assertion that circadian disruption causes unfavorable metabolic symptoms. Thus, an analysis of lifestyle-related factors in evening types coupled with knowledge of SJL afford a more comprehensive picture of health, risk, and disease, and highlight the potential for circadian-focused interventions in preventative health care.

### Table 1

<table>
<thead>
<tr>
<th>Circadian-focused preventive interventions</th>
<th>From</th>
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<tr>
<td>The maximum possible synchronization of individual biological rhythms with social schedules</td>
<td>e.g., Maury E, 2019 [1]</td>
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<tr>
<td>The cultivation of improved sleep hygiene</td>
<td>e.g., Drand R, Sohal H., 2016 [12]</td>
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<tr>
<td>Use of blinds and dark shades in bedrooms, however avoiding extremely dark bedrooms precluding natural light exposure</td>
<td>e.g., Dominioni et al., 2016 [10]</td>
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<tr>
<td>The bedroom light intensity at night should be &lt;5 lux</td>
<td>Obayashi, Saeki &amp; Kurumatani, 2018 [3]</td>
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<tr>
<td>The decreasing evening and increasing morning light exposure</td>
<td>e.g., Lunn et al., 2017 [2]</td>
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<tr>
<td>Use of an alarm clock with the artificial dawn</td>
<td>Giménez et al., 2010 [34]</td>
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<tr>
<td>A short daytime nap (less than 30 minutes)</td>
<td>Zhang, Cajochen &amp; Khatarni, 2019 [13]</td>
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<tr>
<td>Long recovery sleep on the weekends</td>
<td>Åkerstedt et al., 2019 [35]</td>
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<td>The decrease screen-viewing time especially prior to bedtime</td>
<td>e.g., Lemola et al., 2015 [16]</td>
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<tr>
<td>Control of the level of emission of harmful blue-enriched light of the screen by wearing blue-blocker glasses</td>
<td>Van der Lely et al., 2015 [18]</td>
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<tr>
<td>Increasing morning light exposure by using light-emitting goggles</td>
<td>Knufinke et al., 2021 [36]</td>
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<td>Eating during the daylight hours (biological day)</td>
<td>e.g., Mota et al., 2019 [20]</td>
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<td>Regular eating timing (prevention of the eating jetlag)</td>
<td>Zeron-Rugiero et al., 2019 [26]</td>
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<td>A healthy diet with low-calorie foods and increased consumption of fruits and vegetables</td>
<td>e.g., Bae SA et al., 2019 [19]</td>
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<tr>
<td>Avoid unhealthy dietary habits (breakfast skipping, snacking)</td>
<td>e.g., Teixeira GP et al., 2018 [23]; Ma et al., 2020 [22]</td>
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<tr>
<td>Time-restricted feeding regimen in which all caloric intakes occur consistently within an interval ≤12-h every day</td>
<td>e.g., Melkani, Panda, 2017 [24]</td>
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<tr>
<td>Reduced caffeinated drinks intake especially prior to bedtime</td>
<td>e.g., Nunez et al., 2021 [31]</td>
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<tr>
<td>Prohibiting alcohol and tobacco use especially prior to the bedtime</td>
<td>e.g., Patterson et al., 2016 [33]</td>
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<tr>
<td>Regular exercise and physical activity in line with daylight hours, and reducing sedentary behavior time</td>
<td>e.g., Alves MS et al., 2017 [32]</td>
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<tr>
<td>Non-pharmacological intervention as a strategy to shift the biological clock to an earlier time (phase advance)</td>
<td>Facer-Childs et al., 2019 [37]</td>
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</tbody>
</table>
References:


44. Nunez A.N., Rhee J.U., Haynes P., ... & Grandner M.A. Smoke at night and sleep worse? The associations between cigarette smoking with insomnia severity and sleep duration. Sleep Health. 2021. № 7(2). P. 177–182.