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Review Article

Bipolar Disorder and Light Exposure

Yuichi ESAKI
Department of Psychiatry, Okehazama Hospital
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Abstract

The light exposure environment has changed considerably in recent years. It is common for people to spend less time outdoors and therefore have reduced exposure to daylight. In addition, the use of electronic devices, such as smartphones, tablets, and computers, has increased the light exposure at night. Previous studies reported that an inappropriate light exposure environment is linked to negative health effects in humans. As bipolar disorder is associated with light exposure, including bright light therapy, dark therapy, and light hypersensitivity, light exposure in daily life may affect the medical conditions of bipolar disorder. However, to the best of our knowledge, no study has investigated the association between the light exposure environment in daily life and the pathophysiology of bipolar disorder. Therefore, we objectively evaluated the daily light exposure of 218 outpatients with bipolar disorder, and analyzed the association between light exposure and their medical conditions. We found that light exposure is significantly associated with depressive and manic symptoms, sleep quality, and circadian rhythm in patients with bipolar disorder. Further studies are necessary to establish the association between light exposure and recurrence of mood episodes.

Keywords：bipolar disorder, light exposure, circadian rhythm

Introduction

The light exposure environment has changed considerably in recent years. It is common for people to spend less time outdoors and therefore have reduced exposure to daylight. Moreover, the use of electronic devices, such as smartphones, tablets, and computers, has increased light exposure at night. Such an inappropriate light exposure environment, where daytime light exposure is reduced and nighttime light exposure increased, cause several negative effects in humans. Park, Y. M. et al. found that increased nighttime bedroom light exposure was a risk factor for weight gain and obesity 22). Paksarian, D. et al. reported that outdoor artificial light at night was associated with sleep disturbances and the onset of psychiatric disorders 21). Obayashi et al. investigated the association between light exposure in daily life and health in a large cohort study of healthy elderly subjects, which reported that light exposure environment was associated with negative effects in elderly people, such as abnormal melatonin secretion, obesity, arteriosclerosis, and depressive symptoms 17-20). This evidence suggests that the prevalence of artificial light gives not only great benefit to humans, but also great harm.

Bipolar disorder is a severe, recurrent, chronic mental illness characterized by depression and mania. For many years, bipolar disorder has been reported to be associated with light exposure. For instance, patients with bipolar disorder were suggested to be supersensitive to nocturnal melatonin suppression by light compared with healthy subjects and depressed patients 10)15)16). In addition, treatments that manipulate light, including bright light therapy and dark therapy, have been suggested to have a therapeutic effect on bipolar depression and mania 13)14). Therefore, the author believes that the light exposure environment in modern society may have a great impact on the symptoms of patients with bipolar disorder. This study reviewed previous studies on the association between light exposure and bipolar disorder.

I. Association between bipolar disorder and light exposure

1. Bright light therapy

Bipolar disorder has been reported to be closely related to light, and in particular, the association between light exposure and depressive symptoms has been widely reported.

Bright light therapy, which typically involves the use of artificial light of 5000–10,000 lux for a period of 30 min–1 h in the morning, reportedly has a curative effect on depressive episodes in patients with bipolar disorder (Figure 1). Meta-analyses have shown that light therapy is associated with a significant improvement in depressive symptoms compared with control conditions 13)14). However, a previous study has reported that morning light may induce greater risk of hypomanic or mixed symptoms in patients with bipolar disorder 25). Sit, D. K. et al. conducted a randomized controlled trial of bright light therapy between noon and 2:30 p.m. to avoid manic switches and reported that bright light therapy during midday was associated with a significant improvement in depressive symptoms and no manic switches compared with placebo controls 26). Further investigations are needed to clarify the timing of when to perform the light therapy in patients with bipolar disorder.

2. Dark therapy

While daytime light exposure has been reported to be associated with antidepressant effects, nighttime light exposure has been reported to be associated with manic symptoms. Dark therapy, which exposes patients to a dark room from 18:00 to 08:00h, can exert striking beneficial effects on manic patients. Barbini, B., et al. reported that adjunctive dark therapy achieved a 50% reduction in the Young Mania Rating Scale (YMRS) scores for 3 days in 16 patients with acute manic episodes 2). However, dark therapy, in which patients spend 14 hours a day in a completely darkened room, has not become widespread due to difficulties in clinical practice and ethical considerations. In 2016, Henriksen, T. E. et al. conducted a randomized placebo-controlled study of virtual dark therapy using blue-blocking glasses from 18:00 to 08:00h 11). They reported that wearing blue-blocking glasses significantly improved manic symptoms compared to placebo glasses. In a secondary analysis, they reported that wearing blue-blocking glasses significantly improved sleep efficiency and wake after sleep onset compared to placebo glasses 12). In summary, adjunctive treatment with blue-blocking glasses in acutely manic patients is expected to improve not only manic symptoms, but also sleep quality.

3. Abnormal suppression of melatonin secretion due to nighttime light exposure

Bipolar disorder is closely related to abnormal circadian rhythms, in

particular, abnormal melatonin secretion, which is a key circadian phase marker secreted only during the night. Experimental studies have reported that patients with bipolar disorder were supersensitive to nocturnal melatonin suppression by light compared with healthy subjects or patients with major depressive disorder 10)15)16). Therefore, abnormal nocturnal melatonin secretion has been suggested as a trait-marker for bipolar disorder. However, recent an experimental study in 33 patients with bipolar I disorder and 57 controls reported that suppression of melatonin secretion by light exposure was not different between patients with bipolar I disorder and controls 24). Further investigation is needed to clarify about supersensitive to nocturnal melatonin suppression by light in bipolar disorder.

4. Association between day length and bipolar disorder

Bauer, M. et al. investigated the association between solar insolation and age of onset of 5,536 patients with bipolar I disorder in 32 countries. They found that a large increase in springtime solar insolation may impact the onset of bipolar disorder, especially in those with a family history of mood disorders 3). Furthermore, they reported that living in locations with large changes in solar insolation between winter and summer may be associated with increased suicide attempts in patients with bipolar disorder 4). Moreover, Aguglia, A. et al. reported that patients with admissions in spring/summer (a period in which daylight/darkness ratio is longer) showed a higher prevalence of involuntary admission, an earlier age at illness onset, a longer duration of hospitalization, and admission for manic episodes 1). This evidence hints at an association between day length and the age of onset of bipolar disorder, suicide attempts, and psychiatric hospitalization.

II. Finding from APPLE cohort study

Many previous studies have suggested that bipolar disorder is closely associated with light exposure. However, it is unclear how light exposure in daily life, such as exposure to sunlight in the daytime and exposure to artificial light at night, influence the symptoms of bipolar disorder. Therefore, we conducted research on the association between the pathology of bipolar disorder and light exposure in daily life, which we called the APPLE cohort study. The APPLE cohort study was a prospective, naturalistic observational study of 218

outpatients with bipolar disorder that was conducted in two hospitals and two clinics since 2017. The participants were assessed for demographic and clinical characteristics at the clinic and were then asked perform the following for seven consecutive days: (1) wear an actigraph on the wrist of their nondominant arm throughout the day and night, except when bathing or performing aquatic activities (Figure 2a); and (2) record bedroom light levels from bedtime to rising time using a portable photometer (Figure 2b). We indicated finding from APPLE cohort study in the next section.

1. Association between daytime light exposure and depressive symptoms

We analyzed the association between daytime light exposure and depressive symptoms in 181 outpatients with bipolar disorder 5). The average daytime light intensity and the total duration of light intensity of ≥1000 lux were recorded over 7 consecutive days using an actigraph that measured ambient light. Depressive symptoms were assessed using Montgomery–Åsberg Depression Rating Scale, and scores of ≥8 points were treated as depressed state. In multivariable analysis adjusted for age, employment status, age at onset of bipolar disorder, Young Mania Rating Scale score, bedtime, and physical activity, the highest tertile group in average daytime light intensity suggested a significantly lower odds ratio (OR) for depressed state than the lowest tertile group (OR, 0.33; 95% confidence interval [CI], 0.14–0.75; P = 0.009). Similarly, the longest tertile group in light intensity ≥1000 lux duration was significantly associated with lower OR for depressed state than lowest tertile group (OR, 0.42; 95% CI, 0.18–0.93; P = 0.033).

2. Association between nighttime light exposure and manic symptoms

We analyzed the association between nighttime light exposure and manic symptoms in 184 outpatients with bipolar disorder 7). The average light intensity at night during sleep was evaluated using a portable photometer for seven consecutive nights. Manic symptoms were assessed using the YMRS, and scores ≥ 5 points were treated as a "manic state." In multivariable logistic regression analysis adjusted for bipolar disorder type, depressive symptoms, sleep duration, and daytime physical activity, the OR for a hypomanic state was significantly higher for the participants with an average light intensity at night ≥ 3 lux than for those with <3 lux (OR: 2.15, 95% confidence interval: 1.09–

4.22, P = 0.02).

3. Association between nighttime light exposure and sleep quality

Participants were recorded using actigraphy at their homes for seven consecutive nights and were evaluated using the Insomnia Severity Index 6). The average nighttime illuminance in the bedroom during bedtime and rising time was measured using a portable photometer, and the participants were divided into two groups: "Light" (≥5 lux) and "Dark" (<5 lux). The association between nighttime illuminance and sleep parameters was tested with multivariable analysis by adjusting for potential confounders such as age, gender, current smoker, mood state, day length, daytime light exposure, and sedative medications. After adjusting for potential confounders, the actigraphy sleep parameters showed significantly lower sleep efficiency (mean, 80.1% vs. 83.4%; p = 0.01), longer log-transformed sleep onset latency (2.9 vs. 2.6 min; p = 0.01), and greater wake after sleep onset (51.4 vs. 41.6 min; p = 0.02) in the Light group than in the Dark group. Whereas, there were no significant differences in the Insomnia Severity Index scores between the groups. We found that reducing nighttime illuminance may contribute to improved sleep quality in patients with bipolar disorder.

4. Effect of evening light exposure on sleep

We analyzed the association between evening light exposure and subsequent actigraphy sleep parameters in 207 patients with bipolar disorder 9). We measured the white-light illuminance and the irradiance of each wavelength during the 4h before each participant's bedtime. We used a repeated-measures mixed-effect linear regression analysis to evaluate the effect of evening light exposure on subsequent sleep parameters. In a multivariable model adjusted for potential confounders, we found higher white-light illuminance to be significantly associated with lower sleep efficiency (per log lux: 95% CI, −1.328 to −0.133; P = 0.017), prolonged sleep onset latency (95% CI, 0.006 to 0.172; P = 0.035), and longer wake after sleep onset (95% CI, 1.104 to 4.459; P = 0.001). This effect size was larger in the younger age group (aged <44 years) stratified by the median age. Higher irradiance of the blue wavelength range was significantly associated with longer wake after sleep onset, a result similar to those for the green and red wavelength ranges. We observed significant associations between

evening light exposure and subsequent sleep in patients with bipolar disorder.

5. Effect of blue-blocking glasses for the adjunctive treatment of sleep and circadian rhythm

We used a randomized placebo-controlled double-blinded design 8). Outpatients with bipolar disorder and insomnia were randomly assigned to wear either blue-blocking glasses (BB) or clear ones (placebo) which they were instructed to use from 20:00h until bedtime for 2 weeks (Figure 3). The primary outcome metric was the difference in the change from baseline to after intervention in sleep quality, as measured by the visual analog scale (VAS). Forty-three patients were included in this study (BB group, 21; placebo group, 22). The change in sleep quality as per the VAS metric was not significantly different between the two groups (95% CI, −3.34 to 24.72; P = 0.13). However, the Morningness–Eveningness Questionnaire score had shifted to an advanced rhythm in the BB group and to a delayed rhythm in the placebo group, and the difference in these changes was statistically significant (95% CI, 1.69 to 7.45; P = 0.003). Although concurrent medications may have influenced our study, our results suggest that blue-blocking glasses may be useful as an adjunctive treatment for circadian rhythm issues in patients with bipolar disorder.

In summary, the finding from APPLE cohort study and previous studies were that light exposure is associated with depressive symptoms, manic symptoms, sleep quality, circadian rhythm, age at onset of bipolar disorder, suicide attempts, and hospitalization period (Figure 4).

Conclusion

This study reviewed studies on the association between light exposure environment and bipolar disorder. The evidence suggests that appropriate light exposure, such as being exposed to sunlight during the day and avoiding light exposure at night, may contribute to stabilization of symptoms in bipolar disorder. Despite progress in maintenance treatments for bipolar disorder, such as medications and psychotherapy, over 40% of patients with bipolar disorder experience recurrence within 1 year 23). A new treatment option for relapse prevention is necessary. Regulating the light exposure environment, such as being exposed to sunlight in the morning or keeping the bedroom dark at night, can be achieved anywhere by anyone, and it is particularly economical. However,

to the best of our knowledge, evidence on the association between light exposure and bipolar disorder is limited to only a short-term curative effect and a cross-sectional analysis. Thus, further prospective cohort studies are needed to clarify whether light exposure in daily life is associated with preventive effects on relapse of mood episodes in patients with bipolar disorder.

There are no conflicts of interest related to this study

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Figure 1. Bright light therapy

(A)

Actiwatch Spectrum Plus;
Respironics Inc., PA, USA

(B)

LX-28SD; Sato Shoji Inc.,
Kanagawa, Japan

Figure 2. Actigraphy (A) and portable photometer (B)

(A)

Blue-blocking glasses (Yamamoto Kogaku, No. 360S UV Orange, Osaka, Japan)

(B)

Placebo glasses (Yamamoto Kogaku, No. 331, Osaka, Japan)

Figure 3. Blue-blocking glasses (A) and Placebo glasses (B)

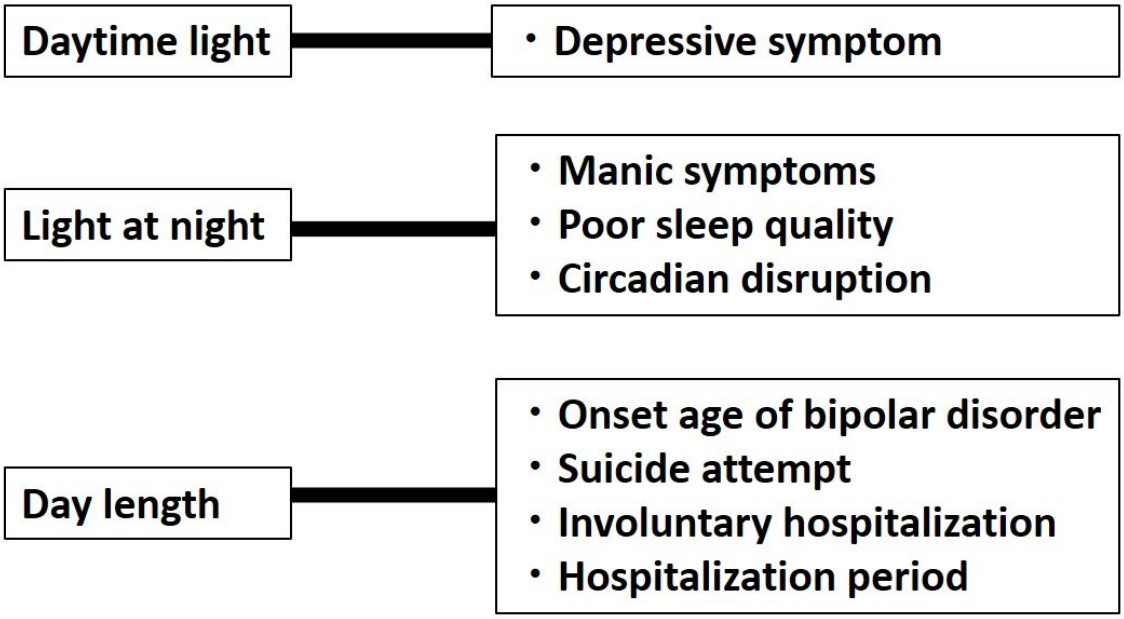

Figure 4. Association between light exposure and bipolar disorder revealed in previous studies and present study