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Measurement of illumination exposure in postpartum women

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Abstract

Background: Low levels of light exposure at critical times are thought to cause seasonal affective disorder. Investigators, in studies demonstrating the usefulness of bright light therapy, also have implicated light's role in non-seasonal depression. The precise cause of postpartum depression has not been delineated, but it seemed possible that new mothers would spend reduced time in daylight. The goal of this study was to examine the levels of illumination experienced by postpartum mothers and to discover any relationship between light exposure and mood levels experienced during the postpartum period.

Methods: Fifteen postpartum women, who did not have any baseline indication of depression, wore a wrist device (Actillume) for 72 hours to measure their exposure to light. At the end of the recording period, they completed a self-reported measure of mood. The mean light exposure of these postpartum women (expressed as the 24-hour average logarithm of illumination in lux) was compared with that of a representative sample of women of comparable age, residence, and seasonal months of recording. Mood levels were then rank-ordered and tested for correlation with light exposure levels.

Results: There was no significant difference between the amount of light [$\log_{10}$lux] experienced by postpartum (1.01 SD 0.236) and control women (1.06 SD 0.285). Mood was not correlated with illumination in the postpartum sample.

Conclusions: Postpartum women in San Diego did not receive reduced light, nor was low mood related to low illumination.

Background

Between 10% and 20% of new mothers experience postpartum depression within the first six months of delivery [1]. It is a significant mood disorder that affects the well-being of both the mother and her infant. Depressed mothers have been found to display negative behaviors towards their infants, which have been shown to adversely affect the child during infancy and in later childhood [2,3]. A more minor and transient condition known as postpartum blues has a much higher incidence, affecting 50% to 80% of new mothers [4]. Its symptoms, which include weeping, sadness, irritability, anxiety, and confusion, often resolve by the second week of delivery [5], but can still have a negative impact on postpartum mothers in the precarious days following birth.

There has been much speculation on possible causes for mood alterations in the postpartum period. Most research

has focused on hormonal changes, previous history of psychiatric disorders, and social milieu as main risk factors for postpartum depression. Low postpartum estrogen levels as well as increased peripartum testosterone levels have been associated with increased depressive and anger symptoms [6,7]. Even lower levels of cholesterol have been linked with symptoms of anxiety, anger, hostility, and depression in the postpartum period [8]. As the diversity of implicated risk factors suggests, postpartum mood disorders, like many psychiatric entities, most likely have a multifactorial etiology which has not been well delineated.

Consequently, effective therapy has been difficult to define, especially with the added complication of treatment effects on the infant for nursing mothers. So far the mainstay of treatment for postpartum depression has rested with oral antidepressants, specifically the SSRI's. This option has frequently generated concern over the potential effects of exposure to the infant through breast-milk.

Thus, there has been the drive to search for alternative methods of treating postpartum mood disorders that minimize the risk of infant exposure through breast-feeding. Parry et. al demonstrated the beneficial effect late-night sleep deprivation had on women who had met the DSM-IV criteria for major depressive disorder with onset within one year postpartum [9]. The efficacy of interpersonal psychotherapy was demonstrated by O'Hara et. al [10]. Grigoriadis et. al reviewed the role of estrogen in treating reproductive-related mood disorders [11]. Exercise, stress-reduction techniques, St. John's Wort, and acupuncture have been suggested as potential therapies without definitive evidence for significant benefit [12]. In 2000 Corral et. al reported cases of two postpartum women suffering from a major depressive episode with postpartum onset who each experienced a 75% reduction in their Hamilton depression scale scores after four weeks of morning bright light therapy via a 10,000-lux light box [13].

Low levels of illumination at dawn or dusk are commonly thought to be associated with seasonal affective disorder, popularizing the concept of light therapy. Research in the past two decades has demonstrated the usefulness of light therapy in other forms of depression. In a review by Kripke in 1998, light therapy was presented as significantly expediting and improving the symptoms of non-seasonal depression both when used alone and in combination with other forms of antidepressant treatment [14]. When combined with antidepressant medications, two European studies from 1992 and 1994 demonstrated that bright light therapy added a relative advantage of 27% [15–17]. In another study by Neumeister et. al in 1996, light therapy decreased symptoms by as much as 35% compared with placebo, when combined with antidepressant medication and late-night sleep deprivation [18]. These effects surpass that demonstrated by antidepressant drugs, alone, over placebo, which recent meta-analyses have described as improving symptoms by 8% to 19% [19–21]. Bright white light therapy has been shown to significantly reduce depression and premenstrual symptoms in women with late luteal phase dysphoric disorder during their menstrual cycles [22–24]. The lower cost, shorter duration of treatment, and lack of overt transmission through breast-milk, relative to extensive interpersonal psychotherapy or antidepressant pharmacotherapy, makes light therapy a potentially viable and appealing alternative treatment for postpartum mood disorders.

Espiritu et. al showed that low levels of light exposure were not necessarily reserved for patients already diagnosed with a depressive disorder [25]. Their survey of randomly selected middle-aged adults in San Diego, California revealed that it was common for a resident of this sunny climate to only be exposed to illumination levels greater than 1000 lux for a mere average 58 minutes per day [25]. Subjects who spent less time in bright illumination were also found to have scored higher on atypical seasonal affective disorder mood questionnaire items [25]. Their results suggested that many Americans, in general, may not be receiving sufficient light exposure to maintain optimal mood [25].

Likewise, it is plausible that postpartum adult women have an additional reason to be subject to less than optimal levels of light. This study examines the levels of illumination experienced by postpartum mothers in their ordinary daily routine and explores the nature of the relationship between their light exposure levels and any abnormal mood symptoms experienced during the postpartum period. We hypothesized that postpartum mothers who were within one year since giving birth experience lower levels of illumination than the average adult woman in San Diego and that this may be due to more time spent indoors caring for a new infant. We also hypothesized that the more depressive mood symptoms in these mothers are correlated with decreasing levels of illumination.

Methods

Recruitment

Subjects were recruited from a general outpatient pediatric clinic at the Perlman Ambulatory Center of the UCSD Medical Center, La Jolla, during July and August of 2000. This clinic serves a population from the middle and upper-middle class suburbs of San Diego County. Subjects targeted were women who had brought infants under one year of age for routine well-baby examinations. The definition of postpartum as within one year of delivery was

implemented to expand the potential sample pool. Referrals came from the practices of four primary care pediatricians at the clinic. If interest was confirmed, the mother signed an Institutional Review Board-approved consent and was sent home with the necessary materials to complete the study for the next three days. A total of fifteen women were eventually recruited for the study.

Data Collection

Each subject was instructed to wear an Actillume wrist device for 72 consecutive hours, whether weekday or weekend, to record her daily exposure to light. Light recorded from the wrist is highly correlated with measurements taken from the forehead above the eyes [26].

The women were encouraged to wear the Actillume at all times with the exception of bathing and to carry on with her normal daily activities during the recording period. At the end of the three days of light recording, one of the authors (EW) visited the mother at her home to retrieve the Actillume, and administered a written one-page screening mood questionnaire to rate her mood levels during the recording period [27,28]. The questionnaire asked the subject to rate the frequency she experienced depressed feelings, restless sleep, enjoyment of life, crying spells, sadness, and dislike by others during the past week. Two additional questions asked if the subject had ever experienced depressive symptoms for two or more weeks in the past year, and if she had ever experienced two or more years of dysthymic mood in her life.

Data Analysis

The Actillume (Ambulatory Monitoring, Inc., Ardsley, NY) is a tiny wrist monitor containing a photometer and a linear accelerometer that measures activity. Recordings of light exposure and activity level were made every minute, twenty-four hours a day, and stored inside the computer memory. A cosine-fitting function was used to convert the daily 24 hour data of lux measurements into mesors (means of fitted cosines) of $\log_{10}$ [lux], which correct for biases due to the time of day that sampling began for each subject and for missing data. For example, if some subjects removed the recorder for bathing in the morning and others bathed at night, the simple means would be biased by the time when the recorder was removed for bathing, but the cosine-fitting would tend to correct partly for the time-of-day missing data. The logarithmic transform was used both because the biological response may be approximately related to the logarithm of illumination intensity and because the distribution of lux measurements was highly skewed (both within subjects and between subjects). Comparison was made by a t-test to see if there was any significant difference in illumination between postpartum women and the control sample.

The control sample consisted of 22 women between the ages of 19 and 44 (mean age 35.35 SD 6.64), selected by random telephone dialing, who also had light exposure and activity levels recorded with the Actillume in a manner similar to the postpartum sample. These recordings occurred during the months of July and August between the years 1990 and 1994. No effect of age or neighborhood on amount of light exposure was found in this sample, providing an appropriate group to compare data with that of the postpartum women. Mood symptoms were not surveyed in this group.

Mood level ratings were plotted against each subject's mean illumination level, and the relationship between light exposure and depressive symptoms among all subjects was tested for correlation using the Spearman rank-order test.

Results

Fifteen women between the ages of 19 and 43, and who were between 1 and 48 weeks postpartum, were recruited (mean age = 32 SD 8.43). All of the women completed the study. One mother reported herself to be an adoptive rather than biological mother of her child; this woman was the primary caregiver of the infant since birth and was not excluded. Ten out of the 15 mothers were under 12 weeks postpartum (median = 8 weeks, mean 13 SD 12.77). None of the subjects had reported a previous diagnosis of postpartum depression. Four mothers reported a previous history of crying spells, not going out, or "depressed mood" after the birth of a previous but not the current child. None of the subjects specifically reported symptoms consistent with a major depressive episode.

From the sample of 22 control women, the mean $\log_{10}$ [lux] of light exposure for the group as a whole was 1.06 SD 0.29 with a range of 0.38 to 1.63 (Figure 1).

From the sample of the fifteen postpartum women who participated in the study, the mean $\log_{10}$ [lux] of light exposure for the group as a whole was 1.01 SD 0.24 with a range of 0.50 to 1.25 (Figure 2).

There was no significant difference between the overall mean illumination levels of postpartum women compared to control women ($t = 0.57$, $p = 0.33$). There was 80% power to distinguish the mean $\log_{10}$ [lux] of the control group from a mean of 0.81 or less among postpartum women (one-tailed t-test, alpha = 0.05). Of the fifteen postpartum women sampled, six experienced individual light exposure levels that were lower than the mean level of 1.06 experienced by control women.

The postpartum sample's mean mood score was 2.7 out of a possible 21. A higher score implicated lower mood

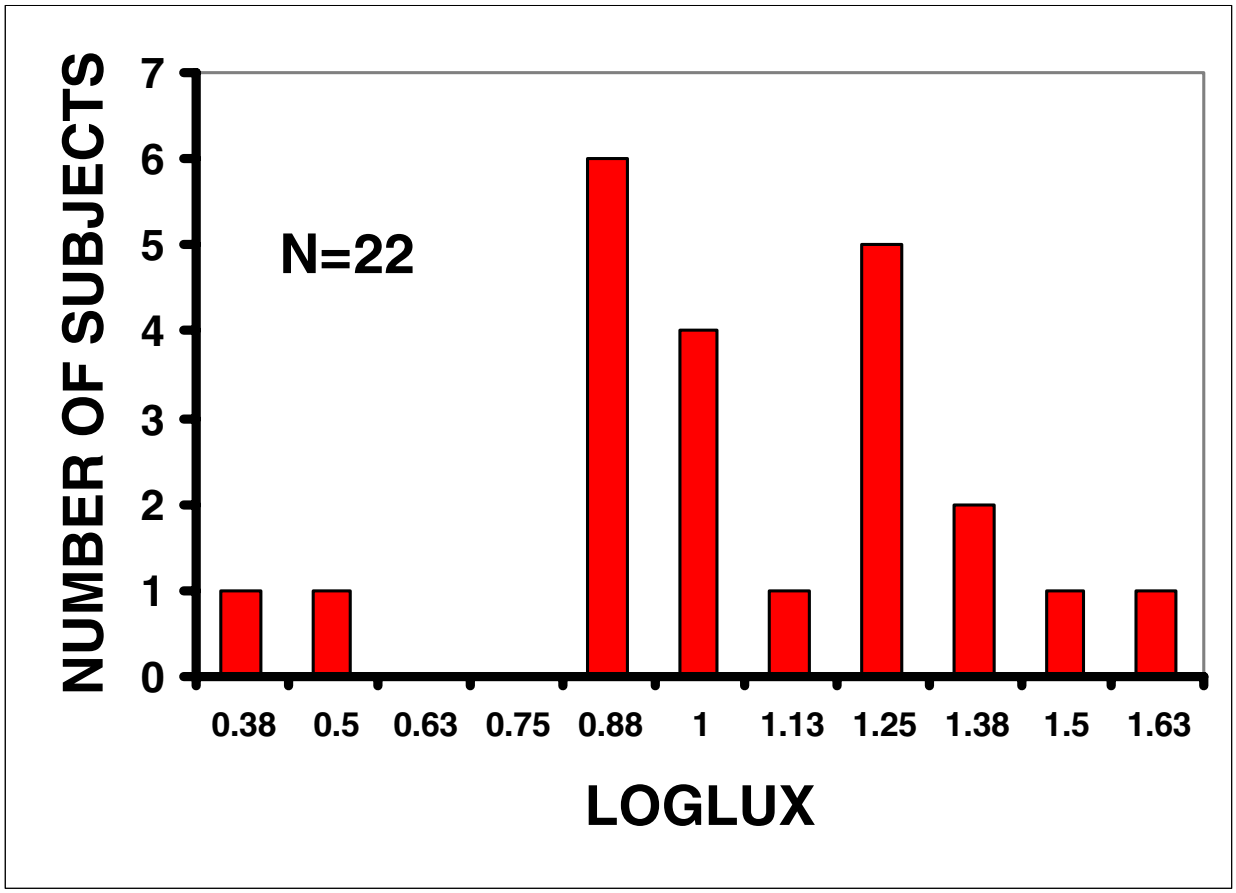

Figure 1
Illumination exposure of control women: range and distribution of illumination levels as experienced by control sample. Mean = 1.06 SD 0.29, N = 22.

levels. The highest score was an 8. 3 out of 15 women scored higher than a 5, which is a screening criterion for depression. Lower mood levels were not correlated with decreasing levels of mean light exposure in the postpartum sample (Figure 3). Rather, the plot suggests a trend of higher illumination correlating with lower mood levels, but this was not significant (r = 0.40, NS).

Discussion

In this postpartum sample, the responsibilities and lifestyle changes of caring for a new infant did not affect the mother's normal propensity to expose herself to light, whether outdoors, in areas of her home that receive natural light through windows, or under artificial lighting of an indoor environment.

The observations are limited to the environment studied. Specifically, the light recordings took place during the summer months of July and August, in San Diego, California. The climate, especially during this time, is predominantly sunny with mild temperatures (average: 21 degrees Centigrade), providing an environment conducive to going outdoors or opening the windows, even with a new infant in the home. Under this environment, the average postpartum mother who does not have other reasons to avoid light, is able to carry on her daily activities, including the care of her infant, without sacrificing her exposure to light that regulates circadian rhythms responsible for many normal biological functions. Under a different environment, such as in communities of more extreme climate, new factors might be introduced that are sufficiently sensitive to the infant to keep the mother away from nat-

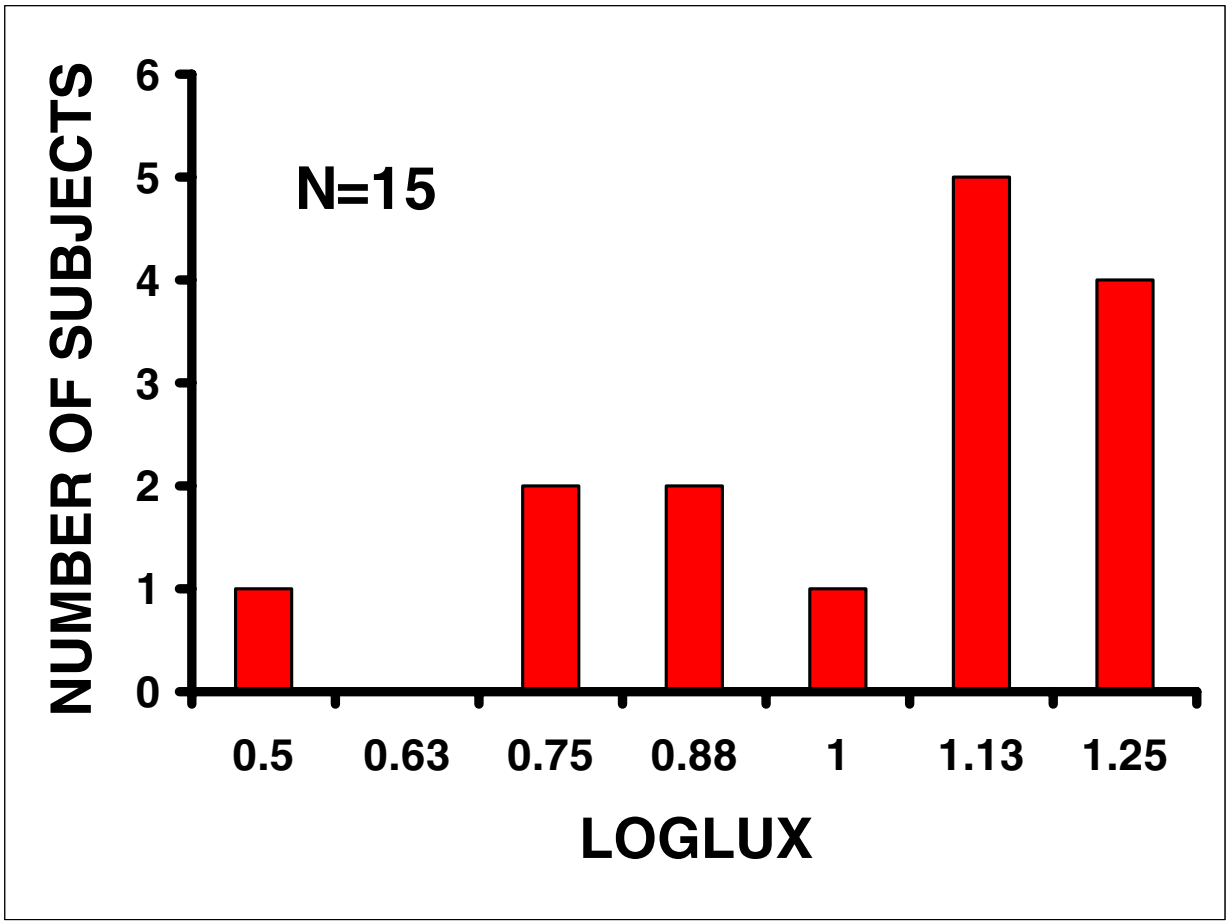

Figure 2
Illumination exposure of postpartum women: range and distribution of illumination levels as experienced by postpartum sample. Mean = 1.01 SD 0.24, N = 15.

ural light, more than it would if she did not have infant care responsibilities.

These results should not be interpreted to mean that postpartum women receive optimal amounts of light exposure. In the study of light exposure experienced by San Diego adults between the ages of 40 and 64 by Espiritu et. al in 1994, of which 50% of the sample were women, the median adult only spent 4.0% of his time in light that was greater than 1000 lux [25], a level that is akin to the light found outdoors in the shade. (Full unobstructed sunlight would be at least 2000 lux and greater.) Although the proportions of time that postpartum women spent in specific levels of light were not analyzed here, a mean exposure level of 1.01 $\log_{10}$ [lux] which equates to 10.2 lux would not suggest that postpartum women spent a large proportion of their day exposed to levels greater than 1000 lux, either. Plots of each subject's data also confirmed that times when the mother was exposed to greater than 1000 lux were few and mostly during midday. According to Espiritu et. al, these illumination levels are well below the representation of the outdoor photoperiod, and it was in a portion of those subjects who spent less time exposed to 1000 lux who reported substantial depressive symptoms [25]. Additionally, these levels are well below that shown to be of beneficial effect in bright light therapy [25]. The postpartum sample in this study as a group was not any better at obtaining optimal amounts of light; however, postpartum status did not make it any worse.

The demonstration that lower mood levels in the postpartum sample did not correlate with lower light can be attributed to several factors. The health of this group was generally good. No woman was in the study sample who

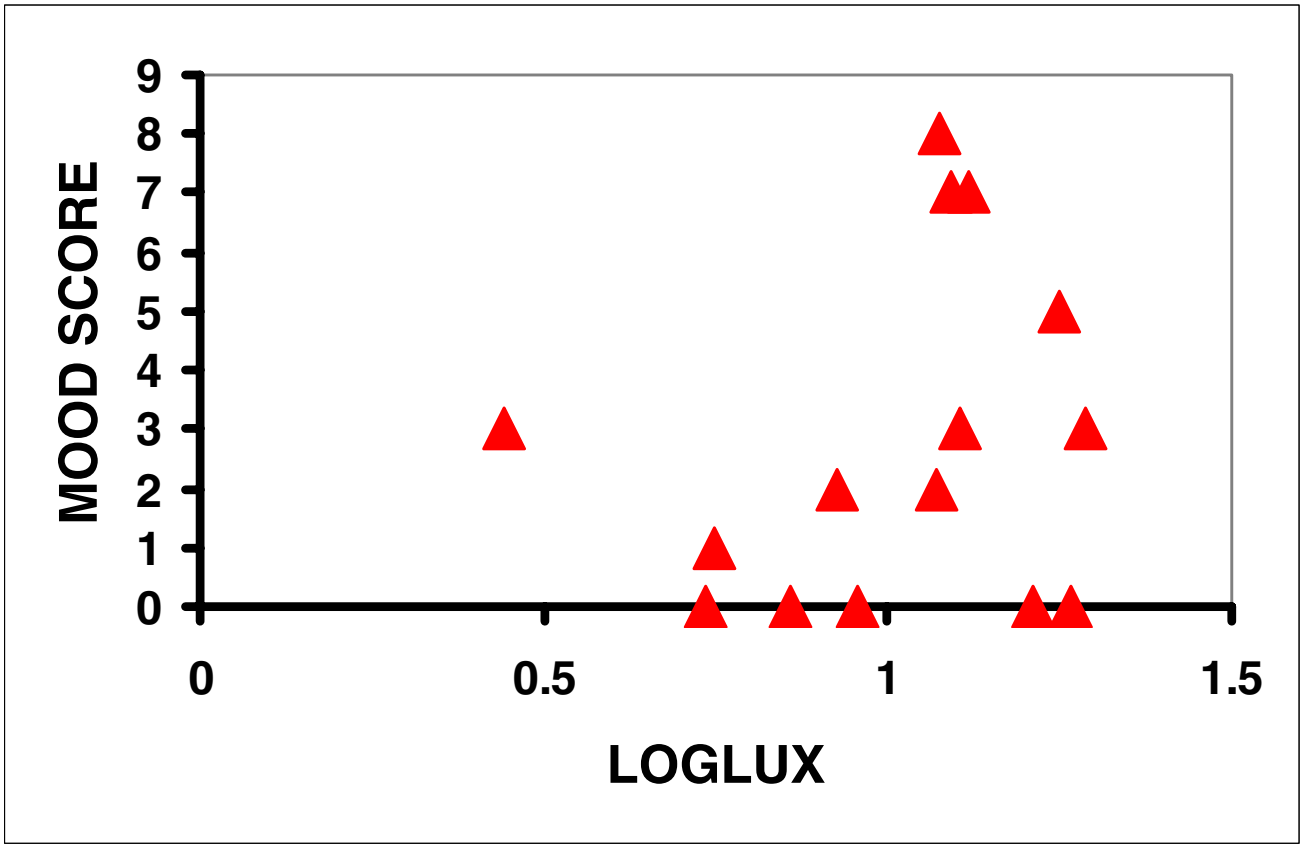

Figure 3
Illumination versus mood in postpartum women: correlation between mood level and light exposure in postpartum subjects. A higher mood score suggests more depressive symptoms. R = 0.40, NS.

met DSM-IV criteria for major depression, as determined by the mood questionnaire, although they were not excluded. A few women reported prior symptoms representative of maternity blues, but they did not experience these symptoms during the study. A summertime effect of the lack of postpartum mood symptoms is possible, but additional research is needed to investigate the significance of seasonal variation in postpartum mood symptoms. Given their overall low mean mood score, the sample in this study might not be truly representative of all postpartum mothers and certainly did not include those with serious postpartum depression.

Postpartum mood alterations, similar to mood changes that occur in other contexts, most likely have a multifactorial etiology. This phenomenon is especially probable during a time when many other rapid changes are occurring for the mother, physiologically and socially. It is not likely that reduced light exposure, alone, could explain why a postpartum mother develops the blues or more serious depression. In light of the observations that many affective disorders can be explained by phase-shifts in circadian rhythms that are correctable by light therapy [29], women with postpartum depression may benefit from critically-timed bright light regardless of their baseline level of light exposure. Circadian rhythms in postpartum women are likely to suffer disturbances secondary to significant changes in estrogen and progesterone, which have been shown to advance and delay rhythms, respectively [30], and it is plausible that bright light can help alleviate this. More investigation is needed in the area of light exposure or light therapy in those women who are concurrently experiencing depressive symptoms or have a history of psychiatric illness.

Conclusions

Postpartum women in San Diego were not exposed to reduced light compared with non-postpartum control women, nor was low mood correlated with low light. Given the study's limitations, the results do not dismiss the ideas that low levels of light could be a factor associated with postpartum affective disorders, or that bright light therapy might be a beneficial treatment option.

Competing interests

None declared.

Authors' contributions

EW carried out the recruitment of the subjects, data collection, data analysis, and drafted the manuscript. DK conceived of the study, its design and coordination, participated in data analysis, and edited the manuscript. MS assisted in the recruitment of subjects and edited the manuscript. BP helped plan the study, interpret the data, and edit the manuscript. All authors read and approved the final manuscript.

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