

Effect of Morning Sun Bathing on Perceived Stress Among Adults: A Single-Group Pre-Post Study Using the Perceived Stress Scale (PSS-10)

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Abstract: ***Background:** Stress is common in adult life, and indoor lifestyles limit exposure to natural light. Morning sunlight helps set the body clock and is linked with sleep and mood, but its relation to perceived stress as a simple daily practice has rarely been examined. **Objective:** To examine whether perceived stress differs before and after regular morning sun bathing among adults. **Methods:** In a quasi-experimental, single-group pre-post study, 100 adults aged 18–60 years (convenience sample) completed the 10-item Perceived Stress Scale (PSS-10; range 0–40), practised morning sun bathing for about 15–20 minutes daily (6:00–9:00 a.m.) for three to four weeks or longer and completed the PSS-10 again. Analyses included the paired t-test, Wilcoxon signed-rank test, Cohen's d, and exploratory subgroup tests. **Results:** All participants completed both assessments (mean age 35.2 years; 70% women). The mean PSS-10 score fell from 24.41 (SD = 4.82) to 20.36 (SD = 5.05), a reduction of 4.05 points (95% CI 3.42 to 4.68), $t(99) = 12.78$, $p < .001$, $d_z = 1.28$; the Wilcoxon test agreed. Scores fell in 90% of participants, and the high-stress group fell from 32% to 8%. The reduction did not differ significantly by demographic subgroups but was larger with higher baseline scores ($\rho = .32$). No participant reported discomfort. **Conclusions:** Perceived stress was lower after morning sun bathing. Without a control group and with self-reported exposure, this is an association, not evidence of causation; controlled studies with objective light, sleep and hormonal measures are needed.*

Keywords: morning sunlight; sun bathing; perceived stress; Perceived Stress Scale; circadian rhythm; adults

1. Introduction

Perceived stress, the judgement that life's demands exceed one's resources to cope (Lazarus & Folkman, 1984), is common in adults and, when persistent, affects emotional wellbeing, sleep and health (Cohen et al., 2007; McEwen, 1998). Natural light is a plausible, low-cost influence. Morning light is a major time cue for the body clock (Roenneberg & Merrow, 2007; Khalsa et al., 2003; Wright et al., 2013), acts on cortisol and serotonin systems (Lambert et al., 2002; Leproult et al., 2001; Scheer & Buijs, 1999), and bright-light therapy helps depressive disorders (Golden et al., 2005). Nature contact is also linked with faster stress recovery and restoration (Kaplan, 1995; Ulrich et al., 1991), though reviews note weak designs (Hansen et al., 2017; Twohig-Bennett & Jones, 2018), and greater sunlight exposure in hospital rooms has also been associated with reduced postoperative analgesic medication use (Walch et al., 2005).

The Perceived Stress Scale was selected because it assesses the extent to which situations in everyday life are appraised as unpredictable, uncontrollable, or overwhelming (Cohen et al., 1983). This makes it appropriate for evaluating subjective stress in community samples. It does not, however, establish psychiatric diagnosis or identify a biological mechanism. The study's primary endpoint is therefore perceived stress rather than physiological stress response.

However, few studies have tested brief, deliberate morning sun exposure in ordinary adults using a validated measure of perceived stress. We therefore examined whether perceived stress on the 10-item Perceived Stress Scale (PSS-10)

differed before and after daily morning sun bathing for three to four weeks or longer, hypothesising a significant reduction.

The rationale for studying morning exposure brings together several related but distinct research traditions. Circadian research establishes that the timing of light influences the human biological clock (Khalsa et al., 2003; Wright et al., 2013). Environmental psychology suggests that time outdoors and natural settings may facilitate psychological restoration (Kaplan, 1995; Ulrich et al., 1991). However, evidence from bright-light treatment, workplace daylight, and nature exposure cannot automatically be treated as evidence for a specific 15–20-minute sun-bathing regimen.

The present investigation therefore focuses on a pragmatic question: whether adults' self-reported stress levels differed after adopting a brief morning sunlight routine. It is an initial observational pre-post assessment, not a trial capable of isolating sunlight from the effects of taking a break, changing a schedule, or spending time outside.

2. Methods

Design and participants: This was a quasi-experimental, single-group pre-post study without a control group. One hundred adults aged 18–60 years were recruited by convenience sampling, and the data were collected from August to September 2026. Adults who consented and experienced routine life stress were eligible; those with diagnosed psychiatric disorders or in psychological treatment for stress were excluded. All 100 completed both assessments, with no missing data.

Procedure and measure: Participants gave informed consent, completed the pre-test, and were asked to spend about 15–20 minutes outdoors in sunlight between 6:00 and 9:00 a.m. daily for three to four weeks or longer, after which they completed the post-test. Practice was self-reported and unverified. Perceived stress was measured with the PSS-10 (Cohen et al., 1983): ten items rated 0–4 for the last month, items 4, 5, 7 and 8 reverse-scored, total 0–40 (higher = more stress); descriptive groups were low (0–13), moderate (14–26) and high (27–40). The scale has good reliability and validity (Lee, 2012; Taylor, 2015). The pre-test form recorded socio-demographic and lifestyle details (age, gender, education, occupation, marital status, usual sleep, exercise, outdoor time and any diagnosed medical condition) together with the PSS-10. The post-test form recorded the practice followed (weeks, minutes per session, time of day and place), the PSS-10 again, and self-rated change in stress, mood and sleep, discomfort and willingness to recommend the practice.

Because the PSS-10 asks about feelings during the preceding month, the recall period at post-test may have overlapped with time before the practice began, especially for participants reporting three weeks of exposure. The study did not objectively monitor light intensity, weather, exact timing, or daily adherence; these details should be captured in subsequent research.

Analysis: Pre- and post-test scores were compared with a paired t-test and, as differences departed from normality (Shapiro & Wilk, 1965), a Wilcoxon signed-rank test (Wilcoxon, 1945). Reliability was assessed with Cronbach's alpha (Cronbach, 1951). Effect size was Cohen's d_z (Cohen, 1988) with a bootstrap 95% CI. Items were tested with Holm's correction (Holm, 1979), group movement with an exact sign test, and subgroups (exploratory) with Mann–Whitney U or Kruskal–Wallis H tests. Significance was $p \leq .05$ (two-tailed). Data were analysed in Python (pandas, SciPy). Ethics: all participants gave informed consent and were told participation was voluntary and confidential.

The analysis was designed to report both magnitude and statistical uncertainty, rather than relying on a p value alone. Descriptive counts were used to show shifts across low, moderate, and high PSS-10 bands; these bands are not diagnostic categories. Item-level and subgroup findings were considered supplementary to the overall pre–post comparison.

3. Results

Participants: As Table 1 shows, participants were mainly young and middle-aged, female and well educated; three in four rarely or almost never spent time outdoors before the study. Most practised as planned (76% for three to four weeks and 24% for longer; 90% for 15–20 minutes), and none reported discomfort.

The sample was predominantly female (70%) and had a mean age of 35.21 years. Most participants reported relatively limited outdoor time before the study, and most reported completing the requested morning exposure duration. These characteristics are important for

understanding feasibility, but convenience sampling restricts generalisation to broader adult populations.

Table 1: Characteristics of the participants and the practice (N = 100)

Characteristic	n or value
Age, years: mean (SD), range	35.21 (9.86), 18–58
Women / men	70 / 30
Graduate, postgraduate or doctorate	83
Private employee or self-employed	60
Usual sleep under 6 h / 6–8 h / 8–10 h	13 / 75 / 12
Outdoors before study: rarely or almost never	74
Practised 3–4 weeks / more than 4 weeks	76 / 24
15–20 minutes per session / more than 20	90 / 10
Place: balcony or terrace	82

Primary outcome: The mean PSS-10 score fell from 24.41 (SD = 4.82) to 20.36 (SD = 5.05), a reduction of 4.05 points (95% CI 3.42–4.68; 16.6%), $t(99) = 12.78$, $p < .001$, $d_z = 1.28$ (95% CI 1.11–1.49); the Wilcoxon test agreed ($Z = 8.31$, $p < .001$) (Table 2, Figure 1). Scores fell in 90 participants, were unchanged in 7 and rose by one point in 3. The high-stress group fell from 32 to 8 (Figure 2); 34 participants moved to a lower group, including 24 of 32 from high to moderate, and none moved higher (exact sign test, $p < .001$). Reliability was good before ($\alpha = .80$) and after ($\alpha = .90$).

Table 2: PSS-10 scores and stress groups before and after morning sun bathing (N = 100)

Measure	Pre-test	Post-test	Change
Mean (SD)	24.41 (4.82)	20.36 (5.05)	4.05 (3.17)
Median (IQR)	24 (22–27)	21 (20–23)	3 (2–6)
Low (0–13), n	4	14	10
Moderate (14–26), n	64	78	14
High (27–40), n	32	8	–24

Paired $t(99) = 12.78$, $p < .001$; $d_z = 1.28$; Wilcoxon $p < .001$.

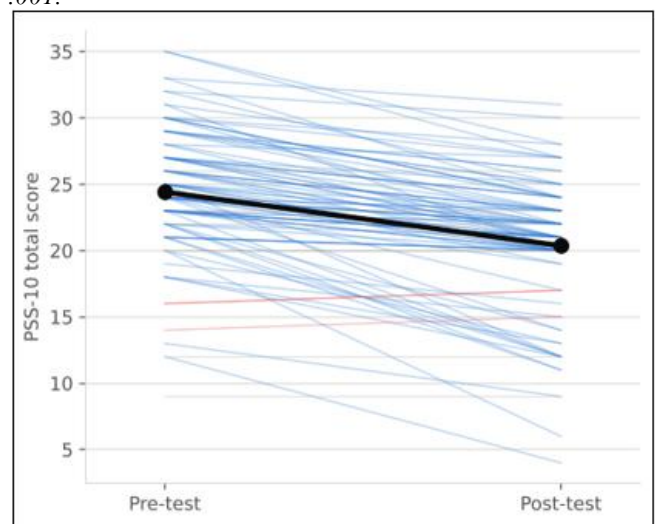


Figure 1: PSS-10 score of each participant before and after the practice (thick line: mean)

Items and subgroups: Scores fell on all ten items, each significant after Holm's correction (Table 3); the largest falls were for feeling nervous and stressed (0.71) and on top of things (0.65), the smallest for confidence in handling problems (0.10). The reduction did not differ significantly

by gender (women 4.17, men 3.77; $p = .525$), age group ($p = .108$), sleep duration ($p = .061$), occupation, education, marital status, exercise, outdoor time or practice duration (all

$p > .19$), and was unrelated to age ($\rho = -.12$) but larger with higher baseline scores ($\rho = .32$, $p = .001$). Small subgroups are descriptive only.

Table 3: Item-wise PSS-10 scores (0–4; higher = more stress)

Item	Content	Pre M	Post M	Change	p (Holm)
1	Upset by something unexpected	2.85	2.33	0.52	< .001
2	Unable to control important things	2.2	1.9	0.3	< .001
3	Felt nervous and stressed	3.19	2.48	0.71	< .001
4 (R)	Confident about handling problems	1.89	1.79	0.1	0.012
5 (R)	Felt things were going my way	2.27	1.89	0.38	< .001
6	Could not cope with all I had to do	2.31	1.94	0.37	< .001
7 (R)	Able to control irritations	2.65	2.44	0.21	0.001
8 (R)	Felt on top of things	2.71	2.06	0.65	< .001
9	Angered by things outside my control	2.05	1.74	0.31	0.001
10	Difficulties piling up too high	2.29	1.79	0.5	< .001

(R) = reverse-scored item.

Self-reports: Seventy-five per cent reported lower stress, 89% better mood and 49% better sleep (none worse); 95% would recommend the practice. Self-rated and measured change agreed ($\rho = .47$, $p < .001$): reductions were 7.33, 4.39 and 2.08 points among those who felt their stress was much lower, somewhat lower and unchanged. Participants who noticed no change in sleep ($n = 51$) still improved by 3.45 points.

The participant-reported experiences offer useful context for the quantitative results. Better mood was reported more often than better sleep, suggesting that perceived benefits were not limited to sleep-related changes. Nevertheless, these responses were collected after participants knew the study's purpose and should be interpreted as subjective feedback rather than independently verified outcomes.

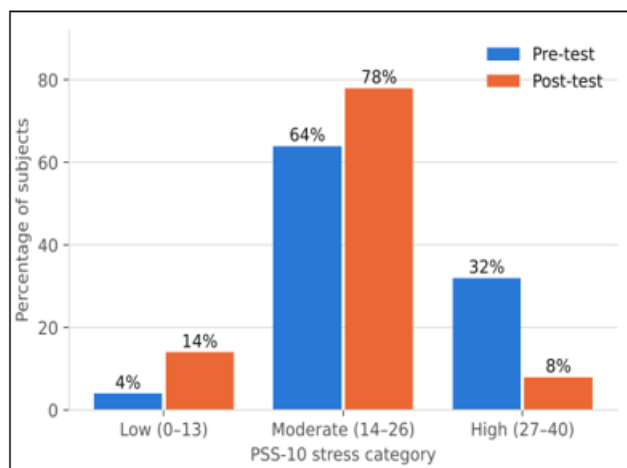


Figure 2: Distribution of low, moderate, and high perceived-stress categories at pre-test and post-test (N = 100)

4. Discussion

Perceived stress was significantly lower after daily morning sun bathing for three to four weeks or longer. The fall was large ($d_z = 1.28$), seen in nine of ten participants, on every item and in all demographic subgroups examined (and more so with higher baseline stress), and moved three-quarters of the high-stress group (24 of 32) into a lower category. Larger falls on tension and on feeling on top of things than on confidence in handling problems fit an appraisal account

in which the practice eases how demands are experienced (Lazarus & Folkman, 1984). The finding is consistent with evidence linking daylight and nature contact to better sleep and stress outcomes (Boubekri et al., 2014; Hansen et al., 2017; Walch et al., 2005).

The reduction in mean PSS-10 score was 4.05 points, equivalent to approximately 16.6% of the baseline mean. The shift from 32 to 8 participants in the high-stress descriptive category provides a complementary way to communicate the change, although these cut-offs are descriptive and not clinical diagnostic thresholds. The reported effect size is based on within-person differences and should not be interpreted as a controlled treatment effect.

No biological variable was measured, so mechanisms remain hypotheses: better circadian alignment (Roenneberg & Merrow, 2007; Wright et al., 2013), effects on cortisol (Leproult et al., 2001), serotonin and mood (Golden et al., 2005; Lambert et al., 2002), or restoration from time outdoors (Kaplan, 1995). Improved sleep alone is unlikely to explain the result, since those reporting no sleep change also improved. Larger falls with higher baseline stress may reflect real benefit or regression towards the mean (Barnett et al., 2005). The findings suggest that lower perceived stress scores were observed following the morning sunlight routine, although the study cannot establish the optimal duration or determine whether sunlight exposure itself produced the reduction.

The item-level pattern is informative but should not be taken as evidence of a specific physiological pathway. Greater reductions in feeling nervous and stressed and in feeling on top of things are compatible with improved subjective coping, but the PSS-10 does not measure cortisol, circadian phase, or exposure intensity. The self-reported improvements in mood and sleep are secondary observations and may be influenced by expectations or changes in lifestyle. The absence of statistically significant subgroup differences does not demonstrate that age, gender, or other characteristics have no influence. These comparisons were exploratory and several groups were small. A future trial should specify subgroup hypotheses in advance, collect baseline information on outdoor activity and sleep, and use a controlled design.

Limitations

The decisive limitation is the lack of a control group: time, season, events, expectation and other lifestyle changes could explain the fall, and single-group effects tend to be overestimated. Further limits are convenience sampling of a mostly female, well-educated group; self-reported exposure; self-report outcomes with participants aware of the aim; overlap of the one-month PSS-10 window with the pre-practice period; uncontrolled sleep and activity; short duration without follow-up; and small subgroup analyses without correction for multiple comparisons.

5. Conclusion

Perceived stress was significantly lower after morning sun bathing for three to four weeks or longer in 100 adults (mean fall 4.05 points), and the practice was well tolerated. Given the single-group design and self-reported exposure, this shows an association, not causation. Controlled studies with objective measures of light, sleep and cortisol are warranted before the practice is recommended for stress management.

6. Recommendations for Future Research

Future research should include larger samples, randomised controlled designs, and long-term follow-up to establish the effectiveness and sustainability of morning sun bathing in reducing stress. Further research may explore optimal sunlight exposure duration and incorporate objective measures such as cortisol levels and sleep quality.

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