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INPLASY

Light at Night and Mental Health: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 26 May 2026 and was last updated on 26 May 2026.

INTRODUCTION

Review question / Objective To systematically evaluate the association between light at night (LAN) exposure and adverse mental health outcomes in human populations through systematic review and meta-analysis.
Secondary objectives:
To stratify analyses by LAN type (indoor vs outdoor), study design (cross-sectional vs cohort), and mental health outcomes (depression vs anxiety vs other psychological disorders).
To assess methodological quality of included studies using NOS and JBI scales.
To explore sources of heterogeneity, test result robustness via sensitivity analysis, and evaluate publication biasTo systematically evaluate the association between light at night (LAN) exposure and adverse mental health outcomes.

Rationale With rapid urbanization, artificial light at night (LAN) has become a widespread environmental pollutant worldwide and disrupts circadian rhythms and melatonin secretion, closely linking to mental health disorders. Mental health problems such as depression and anxiety impose a huge global public health burden. Existing observational studies report inconsistent associations between LAN exposure and mental health, due to differences in study design, exposure assessment methods, and confounding adjustment. No comprehensive meta-analysis has fully synthesized current evidence. This review aims to clarify the overall association, explore subgroup differences, and provide scientific evidence for environmental prevention of mental health problems.Light at night (LAN) is a widespread environmental exposure in modern societies, driven by urbanization, artificial lighting, and screen use, which disrupts circadian rhythms,

melatonin secretion, and sleep regulation. These biological pathways are closely linked to mental health, as circadian dysregulation and sleep disturbances are well-established risk factors for adverse mental health outcomes.

Existing epidemiological studies have reported inconsistent findings regarding the relationship between LAN exposure and mental health. Some studies suggest positive associations between higher LAN exposure and increased risk of depression, anxiety, and psychological distress, while others have found no significant or conflicting results. These discrepancies may stem from variations in study design, LAN exposure assessment methods, population characteristics, and adjustment for key confounding factors (e.g., socioeconomic status, lifestyle, sleep quality).

To date, there is no comprehensive systematic review and meta-analysis synthesizing the available evidence on this topic, nor has there been a formal evaluation of methodological quality and risk of bias across studies. A systematic review is therefore needed to clarify the strength of the association between LAN and adverse mental health outcomes, explore potential sources of heterogeneity, and provide evidence-based insights for public health and clinical practice.

Condition being studied This review focuses on adverse mental health outcomes, including depressive symptoms, anxiety symptoms, bipolar disorder, and other psychological disorders, assessed by validated scales such as CES-D, PHQ-9, GAD-7. The exposure of interest is light at night (LAN), including outdoor LAN measured by satellite remote sensing and indoor LAN assessed by illuminometers or questionnaires. Mental health disorders are major global public health burdens, and LAN is a modifiable environmental risk factor that affects mental health by disturbing circadian rhythm and neuroinflammation.

METHODS

Search strategy ((light exposure[Title/Abstract]) OR (artificial light at night[Title/Abstract]) OR (artificial light-at-night[Title/Abstract]) OR (night time light[Title/Abstract]) OR (nighttime light[Title/Abstract]) OR (night light[Title/Abstract]) OR (bedroom light[Title/Abstract]) OR (light at night[Title/Abstract]) OR (environmental lighting[Title/Abstract]) OR (ambient light[Title/Abstract]) OR (dim light at night[Title/Abstract]) OR (light pollution[Title/Abstract]) OR (domestic light[Title/Abstract])) AND ("Mental Health"[Title/Abstract] OR "Mental Disorder"[Title/Abstract] OR "mental illness"[Title/Abstract] OR anxiety[Title/Abstract] OR depression[Title/Abstract] OR schizophrenia[Title/Abstract] OR "bipolar disorder"[Title/Abstract] OR "Psychopathology"[Title/Abstract] OR "Emotional problem*"[Title/Abstract] OR "Emotional dysregulation"[Title/Abstract] OR "Mood disorder*"[Title/Abstract] OR Depress*[Title/Abstract] OR Anxi*[Title/Abstract] OR stress*[Title/Abstract] OR "affective disorder*"[Title/Abstract] OR "Behaviour problem*"[Title/Abstract] OR "Behavior problem*"[Title/Abstract] OR "Behavioral problem*"[Title/Abstract] OR "Behavioural problem*"[Title/Abstract] OR Suicid*[Title/Abstract] OR non-suicid*[Title/Abstract] OR selfharm[Title/Abstract] OR self-harm*[Title/Abstract] OR selfinjur*[Title/Abstract] OR self-injur*[Title/Abstract]) AND ((humans[Filter]) AND (english[Filter])).

Participant or population All human populations of any age, gender, and geographical setting will be included, covering children, adolescents, adults, and older adults. No restrictions will be applied based on race, ethnicity, or socioeconomic status. Studies focusing exclusively on individuals with pre-existing severe mental disorders (e.g., schizophrenia) or special populations with extreme light exposure (e.g., night-shift workers) will be excluded, as these groups have unique confounding factors that may distort the association between general LAN exposure and mental health outcomes.

Intervention The exposure of interest is light at night (LAN), including both outdoor LAN (measured via satellite remote sensing data of artificial night sky brightness) and indoor LAN (assessed via objective illuminometer measurements or subjective self-reported questionnaires). LAN exposure will be categorized into "high" vs "low" exposure groups according to the definitions provided in the original included studies.

Comparator The comparator group consists of participants with low or no LAN exposure, as defined by the original included studies. This includes individuals living in areas with low outdoor artificial light at night, or those with minimal indoor light exposure during sleep hours.

Study designs to be included We will include observational epidemiological studies that report quantitative data on the association between light at night (LAN) exposure and adverse mental health outcomes. Specifically, these include cross-sectional studies and cohort studies (both prospective and retrospective designs).Reviews,

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meta-analyses, editorials, letters, conference abstracts, commentaries, case reports, and experimental/interventional studies (e.g., randomized controlled trials) will be excluded, as they do not provide original quantitative data on the observational association of interest.

Eligibility criteria Additional inclusion criteria:
1. Studies published in English or Chinese.
2. Studies reporting extractable quantitative effect estimates (e.g., odds ratios, hazard ratios) with 95% confidence intervals (CIs), or sufficient raw data to calculate these effect sizes.
3. Full-text articles are available for detailed review.

Additional exclusion criteria:
1. Duplicate publications of the same dataset or study.
2. Studies with incomplete or unextractable outcome data, even after attempts to contact corresponding authors for clarification.

Information sources Electronic databases including PubMed, Web of Science, Embase, and the China National Knowledge Infrastructure (CNKI) will be systematically searched. The reference lists of all included studies and relevant systematic reviews will be manually checked to identify any potentially eligible studies that were not captured by the initial database searches. Corresponding authors will be contacted via email to request missing or supplementary data if necessary.

Main outcome(s) The primary outcomes are adverse mental health outcomes associated with LAN exposure, including depressive symptoms, anxiety symptoms, and psychological distress, as measured by validated self-report scales (e.g., CES-D, PHQ-9, GAD-7) or clinical diagnostic criteria. The effect measures will be pooled odds ratios (ORs) and hazard ratios (HRs) with 95% confidence intervals (CIs), comparing the highest versus lowest categories of LAN exposure.

Additional outcome(s) Additional outcomes include:
(1) Subgroup analyses to explore potential sources of heterogeneity in the association between LAN exposure and adverse mental health outcomes, stratified by study design (cross-sectional vs. cohort), type of LAN exposure (indoor vs. outdoor), and population characteristics (age groups, gender).
(2) Sensitivity analyses to assess the robustness of the pooled effect estimates, including leave-one-out analysis and exclusion of studies with high risk of bias.
(3) Assessment of publication bias using funnel plots and Egger's regression test, where sufficient studies are available.

Data management All retrieved records will be imported into EndNote for deduplication. Two independent reviewers will screen titles/abstracts and full-text articles using pre-defined eligibility criteria, with disagreements resolved by discussion or consultation with a third reviewer. A standardized Excel-based data extraction form will be used to extract study characteristics, participant demographics, LAN exposure assessment methods, mental health outcome measures, and effect estimates. Extracted data will be double-checked by two reviewers for accuracy. The final dataset will be stored securely and imported into RevMan 5.4 and SPSS 26.0 for meta-analysis.

Quality assessment / Risk of bias analysis The methodological quality and risk of bias of included studies will be independently assessed by two reviewers using design-specific tools. For cohort studies, the Newcastle-Ottawa Scale (NOS) will be used to evaluate selection bias, comparability of groups, and outcome ascertainment (score range: 0–9). For cross-sectional studies, the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies will be applied to assess sampling methods, exposure/outcome measurement, confounding control, and statistical analysis. Disagreements will be resolved through discussion or third reviewer consultation. Studies will not be excluded based on quality scores alone, but their risk of bias will be considered in subgroup and sensitivity analyses.

Strategy of data synthesis For quantitative synthesis, pooled effect estimates (odds ratios or hazard ratios, as reported in primary studies) with 95% confidence intervals (CIs) will be calculated using the inverse variance method. Heterogeneity between studies will be assessed using the I^2 statistic and Cochran's Q test; an $I^2 > 50\%$ will be considered indicative of substantial heterogeneity. A random-effects model will be used for all meta-analyses, as expected due to variations in study populations, exposure assessment methods, and study designs across included observational studies. If quantitative synthesis is not feasible (e.g., due to insufficient comparable data or extreme heterogeneity), a narrative synthesis of the available evidence will be conducted instead. All statistical analyses will be performed using RevMan 5.4 and SPSS 26.0 software.

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Subgroup analysis Subgroup analyses will be performed to explore potential sources of heterogeneity in the association between LAN exposure and adverse mental health outcomes, where a minimum of three studies are available for each subgroup to ensure statistical stability. Predefined subgroups include:
1. Study design: cross-sectional studies vs. cohort studies
2. Type of LAN exposure: outdoor LAN (satellite-measured) vs. indoor LAN (self-reported or objectively measured)
3. Specific mental health outcomes: depressive symptoms vs. anxiety symptoms vs. psychological distress
No additional unplanned subgroup analyses will be conducted.

Sensitivity analysis Sensitivity analyses will be conducted to assess the robustness of the pooled effect estimates. The primary method will be the leave-one-out analysis, where each included study is sequentially excluded to evaluate its influence on the overall pooled result. An additional sensitivity analysis will be performed by excluding studies with high risk of bias (i.e., low scores on the NOS or JBI quality assessment scales) to examine whether the overall conclusion remains consistent. No other sensitivity analyses will be conducted unless specified in the review protocol.

Language restriction Studies published in English and Chinese only.

Country(ies) involved China (all authors are affiliated with Chinese institutions).

Other relevant information No additional relevant information to declare.

Keywords light at night; LAN; mental health; depression; anxiety.

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