INPLASY

Maternal Stress and Mental Health Impacts on Infant EEG Outcomes

INPLASY202580043
doi: 10.37766/inplasy2025.8.0043
Received: 13 August 2025
Published: 13 August 2025

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ADMINISTRATIVE INFORMATION

Support - Operating grants from the Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council, and Social Sciences and Humanities Research Council.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202580043

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 13 August 2025 and was last updated on 13 August 2025.

INTRODUCTION

Review question / Objective The overall objective of this systematic review is to synthesize the literature examining impacts of maternal stress and stressors on infant EEG measures in the first year of life. It will address the following research question: What is the pattern of association between maternal stress and stressors and infant EEG activity?

Rationale Early exposure to adversity has been linked to long-term behavioral and emotional dysregulation. One often-overlooked source of early adversity is maternal stress, to which infants are especially sensitive due to their close biological and emotional connection with their mothers. While research on maternal stress and infant brain development is growing, most studies have focused on prenatal distress and its impact on structural brain outcomes. Far less is known about how maternal stress - particularly postnatal stress - relates to infant brain function as measured by EEG. This gap is partly due to heterogeneity in how maternal stress is conceptualized and assessed (e.g., psychological, socioeconomic, physiological), and how these measures are linked to diverse EEG outcomes. The use of varying EEG paradigms and analytic approaches (e.g., power, asymmetry, aperiodic slope) further limits comparability across studies. Moreover, few studies have examined how distinct types of maternal stress and/or stressor may differentially impact infant EEG profiles. A deeper understanding of how specific EEG metrics uniquely capture infant brain function in the context of maternal stress is critical for identifying early neurobiological markers of risk and resilience.The overall objective of this systematic review is to synthesize the literature examining impacts of maternal stress and stressors on infant EEG measures in the first year of life. It will address the following research question: What is the pattern of association between maternal stress and stressors and infant EEG activity?

Condition being studied This review focuses on infants exposed to maternal postnatal stress and stressors in the first 12 months of life. Infant EEG brain activity will be the main outcome of interest with maternal stress and stressors being the predictor. A narrative review of factors (e.g., type of maternal stress or timing of exposure) that may contribute to the pattern of findings will be conducted.

METHODS

Search strategy A search strategy has been developed in collaboration with an academic librarian. The following databases were searched: Medline (Ovid), Embase, CINAHL, and PsycINFO (Ovid). An initial search of these databases was conducted on March 13th 2025 using the following search strategy:

(
exp Infant/
OR neonat*.ti,ab,id,kw.
OR (baby OR babies).ti,ab,id,kw.
OR newborn*.ti,ab,id,kw.
OR "first year* of life".ti,ab,id,kw.
OR ((preterm* OR prematur* OR pre-term* OR pre-matur*) adj2 (infant* OR neonat* OR bab* OR birth*)).ti,ab,id,kw.
)
AND
(
(postnatal* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (post-natal adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (postpartum* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (post-partum* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (perinatal* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (peri-natal* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (maternal* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR (mother* adj3 (stress* OR distress* OR psychopatholog* OR anxiety* OR anxious* OR depress* OR trauma* OR posttrauma* OR post-trauma* OR internalizing* OR "mental health" OR advers* OR cortisol* OR PTSD*)).mp.
OR "maternal allostatic load".mp.
OR (maternal* adj3 affect* adj3 disord*).mp.
OR (maternal* adj3 mood* adj3 disord*).mp.
OR Edinburgh postnatal depression scale:.mp.
OR parenting stress index:.mp.
OR parental stressor scale:.mp.
OR Maternal Postnatal Attachment Scale:.mp.
OR exp Depression, Postpartum/
OR (State-Trait Anxiety Inventory.mp. AND exp Mothers/)
OR (Posttraumatic Stress Disorder Checklist:.mp. AND exp Mothers/)
OR (beck depression inventory:.mp. AND exp Mothers/)
OR (family adj3 income*).ti,ab,id,kw.
OR poverty.ti,ab,id,kw.
OR SES*.ti,ab,id,kw.
OR (socioeconomic adj2 status).ti,ab,id,kw.
OR Poverty/
OR exp Socioeconomic Factors/
OR exp employment/
OR exp housing instability/
OR exp income/
OR exp Low Socioeconomic Status/
OR exp Educational Status/
OR (hollingshead* adj2 ind*).mp.
OR (hollingshead* adj5 SES).mp.
OR (education* adj3 attain*).ti,ab,id,kw.
OR (education* adj3 level*).ti,ab,id,kw.
)
AND
(
exp Electroencephalography/
OR exp Magnetic Resonance Imaging/
OR exp Neuroimaging/
OR Functional Neuroimaging/
OR Spectroscopy, Near-Infrared/
OR exp Magnetoencephalography/
OR exp Diffusion Tensor Imaging/
OR exp Diffusion Magnetic Resonance Imaging/
OR exp White Matter/
OR exp Brain Mapping/
OR exp Neural Pathways/
OR exp electroencephalography phase synchronization/

OR exp alpha rhythm/
OR exp beta rhythm/
OR exp delta rhythm/
OR exp gamma rhythm/
OR exp theta rhythm/
OR exp cortical excitability/
OR exp evoked potentials/
OR exp brain waves/
OR (frontal adj3 asymmetr*).mp.
OR (resting adj3 brain adj3 activ*).mp.
OR (resting adj3 cortical adj3 activ*).mp.
OR (resting adj3 neural adj3 activ*).mp.
OR (event* adj3 related* adj3 potential*).mp.
OR (brain adj3 activ*).mp.
OR (neural adj3 activ*).mp.
OR (cortical adj3 activ*).mp.
OR (neural adj3 correlate:).mp.
OR EEG*.ti,ab,id,kw.
OR fMRI*.ti,ab,id,kw.
OR fNIRS*.ti,ab,id,kw.
OR MRI*.ti,ab,id,kw.
OR MEG*.ti,ab,id,kw.
OR (EEG* adj3 frequenc*).mp.
OR (EEG* adj3 activ*).mp.
OR (EEG* adj3 power*).mp.
OR (EEG* adj3 asymmetr*).mp.
OR (brain adj3 frequenc*).mp.
OR (brain adj3 wave*).mp.
OR (cortical adj3 frequenc*).mp.
OR (power* adj3 (theta OR gamma OR delta OR alpha OR beta)).ti,ab,id,kw.
OR microstate*.ti,ab,id,kw.
)
AND Humans/

While screening full text, it was concluded that the included studies (which included structural and functional brain outcomes) were too broad, rendering the review unmanageable. Thus, at the full text screening stage, any paper that examined non-EEG infant brain outcomes was excluded at the full text screening stage.

Participant or population The review will focus on all infants in the first 12 months of life and their mothers.

Intervention All infant samples exposed to maternal stress and/or stressors will be included. For RCTs or experimental studies investigating the effects of an intervention on mothers' stress or stressors and its subsequent impacts on infant EEG outcomes will be considered.

Comparator N/A.

Study designs to be included Any original empirical article will be considered eligible for inclusion. Review articles, commentaries, conference proceedings, case studies, and dissertations will not be included.

Eligibility criteria Studies that meet the following eligibility criteria are being selected for inclusion: 1) original empirical article; 2) study conducted with mother-infant dyads within infants' first 12 months of life; 3) includes a measure of maternal stress or stressor; and 4) infant EEG measures collected and examined in relation to maternal stress or stressors.

Studies are not excluded based on language, time frame, country or setting. Only peer-reviewed published studies will be included.

Information sources The following databases were searched: Medline (Ovid), Embase, CINAHL, and PsycINFO (Ovid). The reference lists of relevant reviews/chapters were also manually inspected to ensure completeness.

Main outcome(s) The main outcomes of interest will include:
• Infant EEG responses – includes resting and event-based EEG paradigms.

The main measures of effect will include:
• Primarily association statistics, such as correlations or standardized beta values if available will be qualitatively examined to describe the association between maternal stress/stressors and infant EEG measures.

Additional outcome(s) N/A.

Data management Four authors (SJ, AL, HH, LH) will be responsible for conducting title/abstract screening and full-text review to identify articles that meet criteria for inclusion. Data extraction was performed by AL, HH, and LH and double screened by SJ using a data extraction template developed in consultation with the senior author (RPR). Inter-rater reliability will be assessed and tracked and disagreements will be resolved via discussion and consultation with the senior author (RPR), as needed.
The following data will be extracted from each study:
• Participant data (gestational age, postnatal age, sex, sample size, country of recruitment, and inclusion/exclusion criteria [e.g., sample-specific clinical history, medication, birthweight, past illnesses, previous pain exposure]).
• Type of maternal stress or stressor examined

• Type of infant EEG outcome measure
• Any magnitude statistics on the association between maternal stress or stressor and infant EEG will also be extracted for a qualitative review where possible.

Covidence software and Microsoft Excel were used to record inclusion/exclusion decisions throughout the systematic review process, as well as for data extraction and risk of bias judgements.

Quality assessment / Risk of bias analysis Four authors (SJ, AL, HH, LH) will independently assess the risk of bias of included studies using an adapted risk of bias tool developed for the current review and informed by the the Risk of Bias in Non-Randomized Studies – of Exposure (ROBINS-E) tool, and published guidelines pertaining to best practices in the measurement and analysis of electroencephalography (EEG) outcome measures. Inter-rater reliability will be assessed, and disagreements will be resolved via discussion and consultation with the senior author (RPR).

Strategy of data synthesis A meta-analysis is not be feasible due to significant variability across studies in sample characteristics, study methodology, outcomes, and statistical analyses; thus, a narrative synthesis will be selected over meta-analysis techniques. Cohen's d effect sizes or standardized beta estimated will be computed if available but will be compared in a qualitative manner. A formal framework for conducting narrative reviews would be employed to consolidate the relevant studies and draw conclusions that address our research question (Popay et al., 2006). This will be done for each subgroup analysis described in the next item.

Subgroup analysis Subgroup narrative synthesis will be performed based on the different types of maternal stress and stressors (e.g., maternal physiological stress, maternal mental health symptomatology, maternal perceived stress and maternal contextual stress). Under each section, we will further examine their impacts on infant EEG outcomes, primarily EEG asymmetry, EEG power, and any other EEG outcome if applicable for that subgroup.

Sensitivity analysis The authors may conduct qualitative robustness checks by excluding studies that have a high risk of bias rating to determine if conclusions about association changes. This will be done for each subgroup analysis.

Language restriction No language restrictions were imposed in the search strategy.

Country(ies) involved Canada and UK.

Keywords infant, maternal mental health, maternal postpartum stress, socioeconomic stress, electroencephalography, EEG.

Dissemination plans Review findings will be published in a peer-reviewed journal and presented at academic conferences.

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