**Supplementary Online Content**

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**Table S1.** PRISMA Checklist1

|  |  |  |  |
| --- | --- | --- | --- |
| Section/topic | # | Checklist item | Reported on page # |
| **TITLE** |
| Title | 1 | Identify the report as a systematic review, meta-analysis, or both | 1 |
| **ABSTRACT** |
| Structured summary | 2 | Provide a structured summary including, as applicable: background, objectives, data sources, study eligibility criteria, participants, and interventions, study appraisal and synthesis methods, results, limitations, conclusions and implications of key findings, systematic review registration number | 3 |
| **INTRODUCTION** |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known | 4-6 |
| Objectives | 4 | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS) | 6 |
| **METHODS** |
| Protocol and registration | 5 | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number | 6 |
| Eligibility criteria | 6 | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale | 7-8 |
| Information sources | 7 | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched | 7 |
| Search | 8 | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated | 7, Table S2 |
| Study selection | 9 | State the process for selecting studies (i.e., screening, eligibility, including in systematic review, and if applicable, included in the meta-analysis) | 7-8 |
| Data collection process | 10 | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators | 7-8 |
| Data items | 11 | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made | 7-9 |
| Risk of bias in individual studies | 12 | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis | 8-9 |
| Summary measures | 13 | State the principal summary measures (e.g., risk ratio, difference in means) | 9-10 |
|  |  |  |  |
|  |  |  |  |
| Synthesis of results | 14 | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis | 9-10 |
| Risk of bias across studies | 15 | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies) | 8-9 |
| Additional analyses | 16 | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified | 9-10 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
| Section/topic | # | Checklist item | Reported on page # |
| **RESULTS** |
| Study selection | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusion at each stage, ideally with a flow diagram | 8;11; Figure 1 |
| Study characteristics | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide citations | 11; Table 1 |
| Risk of bias within studies | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12) | 11-12; Table S5 |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: a) simple summary data for each intervention group, b) effect estimates and confidence intervals, ideally with a forest plot | 10-11; Figures 2 and 3 |
| Synthesis of results | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency | 12-13; Figures 2 and 3; Tables S6 to S9 |
| Risk of bias across studies | 22 | Present results of any assessment of risk of bias across studies (see item 15) | 11-12 |
| Additional analysis | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see item 16]) | 12-13 |
| **DISCUSSION** |
| Summary of evidence | 24 | Summarize the main findings including the strength of evidence for each main outcome, consider their relevance to key groups (e.g., healthcare providers, users, and policymakers) | 13-19 |
| Limitations | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias) | 18-19 |
| Conclusions | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research | 17-18 |
| **FUNDING** |
| Funding | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data), role of funders for the systematic review | 2 |

1 From *Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Medicine, 6(7), e1000097. doi:*[*https://doi.org/10.1371/journal.pmed.1000097*](https://doi.org/10.1371/journal.pmed.1000097)

**Table S2.** Search equations

|  |  |
| --- | --- |
| Database | Search equation |
| PubMed MEDLINE | (((postnatal OR postpartum OR perinatal OR peri-natal OR antenatal) ADJ3 (depress\*)) OR ((matern\* OR mother\* OR mothers/) AND (depress\* OR depression/ OR major depression/ OR minor depression/)) OR exp portpartum depression) AND (cognitive development OR exp child development/ OR exp cognition/ OR cogniti\* or language\* or verbal or intelligen\* or academic\* or read\* or writing or development or learning) |
| Embase | [[((depress\* adj3 (post natal or postnatal or postpartum or post partum or perinatal or peri-natal or antenatal)).ab,kw,ti.) OR (exp minor depression/ or exp perinatal depression/ or exp postnatal depression/ or exp major depression/ or exp antenatal depression/ or exp depression/)] AND [(exp mother/) OR ((mother\* or matern\*).ab,kw,ti.)]] AND [(exp cognition/) OR (exp child development/) OR (exp language development/ or exp language/) OR (exp intelligence test/ or exp intelligence quotient/ or exp intelligence/) OR ((cognit\* or language\* or verbal or memory or intelligen\* or academic\* or read\* or writing or development).ab,kw,ti.)] |
| ERIC | ((MAINSUBJECT.EXACT.EXPLODE("Depression (Psychology)") OR (ab(depress\* NEAR/3 post natal OR postnatal OR postpartum OR post partum OR perinatal OR peri-natal OR antenatal) OR if(depress\* NEAR/3 post natal OR postnatal OR postpartum OR post partum OR perinatal OR peri-natal OR antenatal) OR ti(depress\* NEAR/3 post natal OR postnatal OR postpartum OR post partum OR perinatal OR peri-natal OR antenatal))) AND ((ab(mother\* OR matern\*) OR if(mother\* OR matern\*) OR ti(mother\* OR matern\*)) OR MAINSUBJECT.EXACT.EXPLODE("Mothers"))) AND (MAINSUBJECT.EXACT.EXPLODE("Cognitive Development") OR MAINSUBJECT.EXACT.EXPLODE("Child Development") OR (MAINSUBJECT.EXACT.EXPLODE("Child Language") OR MAINSUBJECT.EXACT.EXPLODE("Language")) OR MAINSUBJECT.EXACT.EXPLODE("Intelligence") OR (ab(cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development) OR ti(cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development) OR if(cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development))) |
| PsycINFO | ((((((**MeSH**: (depression))))) *OR* ((((**abstract**: (depress\* NEAR/3 post natal))) *OR* ((**abstract**: (postnatal))) *OR* ((**abstract**: (postpartum))) *OR* ((**abstract**: (post partum))) *OR* ((**abstract**: (perinatal))) *OR* ((**abstract**: (peri-natal))) *OR* ((**abstract**: (antenatal)))) *OR* (((**Keywords**: (depress\* NEAR/3 post natal))) *OR* ((**Keywords**: (postnatal))) *OR* ((**Keywords**: (postpartum))) *OR* ((**Keywords**: (post partum))) *OR* ((**Keywords**: (perinatal))) *OR* ((**Keywords**: (peri-natal))) *OR* ((**Keywords**: (antenatal)))) *OR* (((**title**: (depress\* NEAR/3 post natal))) *OR* ((**title**: (postnatal))) *OR* ((**title**: (postpartum))) *OR* ((**title**: (post partum))) *OR* ((**title**: (perinatal))) *OR* ((**title**: (peri-natal))) *OR* ((**title**: (antenatal)))))) *AND* (((((**abstract**: (mother\*))) *OR* ((**abstract**: (matern\*)))) *OR* (((**Keywords**: (mother\*))) *OR* ((**Keywords**: (matern\*)))) *OR* (((**title**: (mother\*))) *OR* ((**title**: (matern\*))))) *OR* ((((**MeSH**: (mother))))))) *AND* ((((**abstract**: (cognit\*)) *OR* (**abstract**: (language\*)) *OR* (**abstract**: (verbal)) *OR* (**abstract**: (memory)) *OR* (**abstract**: (intelligen\*)) *OR* (**abstract**: (academic\*)) *OR* (**abstract**: (read\*)) *OR* (**abstract**: (writing)) *OR* (**abstract**: (development))) *OR* ((**Keywords**: (cognit\*)) *OR* (**Keywords**: (language\*)) *OR* (**Keywords**: (verbal)) *OR* (**Keywords**: (memory)) *OR* (**Keywords**: (intelligen\*)) *OR* (**Keywords**: (academic\*)) *OR* (**Keywords**: (read\*)) *OR* (**Keywords**: (writing)) *OR* (**Keywords**: (development))) *OR* ((**title**: (cognit\*)) *OR* (**title**: (language\*)) *OR* (**title**: (verbal)) *OR* (**title**: (memory)) *OR* (**title**: (intelligen\*)) *OR* (**title**: (academic\*)) *OR* (**title**: (read\*)) *OR* (**title**: (writing)) *OR* (**title**: (development)))) *OR* (((**MeSH**: (intelligence)))) *OR* (((**MeSH**: (language)))) *OR* (((**MeSH**: (child development)))) *OR* (((**MeSH**: (cognition))))) |
| CINAHL | ((MH "Depression+") OR (MH "Depression, Postpartum") OR (AB ( depress\* N3 post natal or postnatal or postpartum or post partum or perinatal or peri-natal or antenatal ) OR TI ( depress\* N3 post natal or postnatal or postpartum or post partum or perinatal or peri-natal or antenatal ))) AND ( (AB ( mother\* or matern\* ) OR TI ( mother\* or matern\*) OR (MH "Mothers+")) AND ((MH "Cognition+") OR (MH "Child Development") OR (MH "Language+") OR (MH "Language Development") OR (MH "Intelligence+") OR (AB ( cognit\* or language\* or verbal or memory or intelligen\* or academic\* or read\* or writing or development ) OR TI ( cognit\* or language\* or verbal or memory or intelligen\* or academic\* or read\* or writing or development ) )) |
| Scopus | (((KEY (depression)) OR (TITLE-ABS-KEY (depress\* W/3 post AND natal OR postnatal OR postpartum OR post AND partum OR perinatal OR peri-natal OR antenatal))) AND ((TITLE-ABS-KEY (matern\* OR mother\*)) OR (KEY(mother)))) AND ((KEY (cognition)) OR (KEY (child AND development)) OR (KEY(language)) OR (KEY (intelligence)) OR (TITLE-ABS-KEY (cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development))) AND (LIMIT-TO (EXACTKEYWORD, “Depression”) OR LIMIT-TO (EXACTKEYWORD, “Mother”) OR LIMIT-TO (EXACYKEYWORD, “Cognition”) OR LIMIT-TO (EXACTKEYWORD, “Child Development”) OR LIMIT-TO (EXACTKEYWORD, “Cognitive Development”) OR LIMIT-TO (EXACTKEYWORD, “Language Development”) OR LIMIT-TO (EXACTKEYWORD, “Intelligence”)) |
| ProQuest | ((su(depression) OR (ab(depress\* NEAR/3 post natal OR postnatal OR postpartum OR post partum OR perinatal OR peri-natal OR antenatal) OR ti(depress\* NEAR/3 post natal OR postnatal OR postpartum OR post partum OR perinatal OR peri-natal OR antenatal))) AND ((ab(mother\* OR matern\*) OR ti(mother\* OR matern\*)) OR su(mother))) AND (su(cognition) OR su(child development) OR su(language) OR su(intelligence) OR (ab(cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development) OR ti(cognit\* OR language\* OR verbal OR memory OR intelligen\* OR academic\* OR read\* OR writing OR development))) |

**Table S3.** Study quality assessment criteria1

|  |  |  |
| --- | --- | --- |
| **Item** | **Title** | **Criteria** |
| 1 | Clear research question | Was research question/objective clearly stated? |
| 2 | Defined sample | Was study population (who, when, where) clearly specified and defined? |
| 3 | Participation rate >50% | Was participation rate of eligible persons at least 50%? |
| 4 | Selection criteria noted | Were all the subjects selected from the same/similar populations (including the same time period)? Were inclusion/exclusion criteria for being in the study prespecified and applied uniformly? |
| 5 | Power calculation | Was a sample size justification, power description, or variance and effect estimates provided? |
| 6 | Exposure measured prior to outcome | For the analyses in this paper, was the exposure of interest measured prior to the outcome being measured? |
| 7 | Timeframe sufficient | Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed? Sufficient timeframe was defined as $\geq $4 months2 |
| 8 | Continuous exposure variables | For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?  |
| 9 | Valid exposure measure | Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? |
| 10 | Times | Was the exposure assessed more than once over time? |
| 11 | Valid outcome measure | Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? |
| 12 | Blinding | Were the outcome assessors blinded to the exposure status of participants? |
| 13 | Attrition $\leq $ 20% | Was loss to follow-up after baseline 20% or less? |
| 14 | Confound variables | Were key potential confounding variables measured and adjusted statistically for their impact on the association between exposure and outcome in girls and boys separately? |

1Adapted from National Heart Lung and Blood Institute: National Institutes of Health. (2014). Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. Retrieved from <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools> and Rogers, A., Obst, S., Teague, S.J., Rossen, L., Spry, E.A., Macdonald, J.A., Sunderland, M., Olsson, C.A., Youssef, G., & Hutchinson, D. (2020). Association between maternal perinatal depression and anxiety and child and adolescent development: a meta-analysis. *JAMA Pediatrics*. DOI: <https://doi.org/10.1001/jamapediatrics.2020.2910>

2 Liu, Y., Kaaya, S., Chai, J., McCoy, D. C., Surkan, P. J., Black, M. M., . . . Smith-Fawzi, M. C. (2017). Maternal depressive symptoms and early childhood cognitive development: a meta-analysis. *Psychological Medicine, 47*(4), 680-689. doi:<https://doi.org/10.1017/s003329171600283x>

**Table S4.** Meta-analysis and conversion of estimates to Hedges’ *g* effect sizes formulae

|  |  |
| --- | --- |
| **Estimate** | **Formula** |
| **Meta-analysis estimates** |
| Hedges’ *g* | **1 –** $\left[\frac{3}{4\left(n\_{1}+ n\_{2}-2\right)-1}\right] x \left[\frac{\overline{X}\_{1}- \overline{X}\_{2}}{\sqrt{\frac{\left(n\_{1}-1\right)S\_{1}^{2}+(n\_{2}-1)S\_{2}^{2}}{n\_{1}+ n\_{2}-2}}}\right]$ |
| I2 | $\left[\frac{Q-df}{Q}\right]$ *x* 100% |
| **Conversion of estimates to Hedges’ g** |
| Pearson correlation | Effect sizes were manually calculated from each study using formulae retrieved from the book “Introduction to meta-analysis”1:**1 –** $\left[\frac{3}{4\left(n\_{1}+ n\_{2}-2\right)-1}\right]$ *x* $\left[\frac{2r}{\sqrt{1-r^{2}}}\right]$ |
| Regression coefficient | The *esc2* R package was used to convert regression coefficients into Hedges’ *g* effect sizes based on formulae from the book “Practical meta-analysis”3:**1 –** $\left[\frac{3}{4\left(n\_{1}+ n\_{2}-2\right)-1}\right]$ *x* $\left[\frac{b}{\sqrt{\frac{\left(n\_{1}-1\right)S\_{1}^{2}+(n\_{2}-1)S\_{2}^{2}}{n\_{1}+ n\_{2}-2}}}\right]$ |

1 Borenstein, M., Hedges, L., Higgins, J., & Rothstein, H. (2011). Chapter 7: Converting among effect sizes. In: *Introduction to meta-analysis.* United Kingdom: John Wiley & Sons.

2 Wilson, D.B. (2016) Formulas Used by the "Practical Meta-Analysis Effect Size Calculator". Unpublished manuscript: George Mason University

3 Lipsey, M.W. & Wilson, D.B. (2001). *Practical meta-analysis*. Thousand Oaks, California: Sage Publications

**Table S5.** Quality assessment of included studies

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Citation** | **Clear research question** | **Defined sample** | **Participation rate >50%** | **Selection criteria noted** | **Power calculation** | **Exposure measured prior to outcome** | **Timeframe sufficient** | **Continuous exposure variable** | **Valid exposure measure** | **Times** | **Valid outcome measure** | **Blinding** | **Attrition** $\leq $ **20%** | **Confounding** |
| Ahun et al., 2020 | Y | Y | Y\* | Y\* | N | Y | Y | Y | Y | Y | Y | NR | N | Y |
| Cornish et al., 2005 | Y | N | Y | Y | N | Y | Y | N | Y | Y | Y | Y | Y | N |
| Davies et al., 1997 | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | N | NR | Y | N |
| Donald et al., 2019 | Y | Y | NR | Y | N | Y | Y | Y | Y | N | Y | Y | N | N |
| Hay et al., 2001 | Y | Y\* | Y | NR | N | Y | Y | N | Y | N | Y | Y | Y | N |
| Hay et al., 2008 | Y | Y | Y | NR | N | Y | Y | N | Y | Y | Y | NR | Y | N |
| Murray et al., 1996 | Y | Y | Y | Y | N | Y | Y | N | Y | Y | Y | Y | Y | N |
| Murray et al., 2010 | Y | Y | Y\* | Y | Y | Y | Y | N | Y | Y | Y | NR | Y | N |
| Ng-Knight et al., 2018 | Y | Y | N | N | N | Y | Y | Y | Y | Y | Y | NR | N | Y |
| Nolvi et el., 2018 | Y | N | Y | Y | N | Y | Y | Y | Y | Y | Y | NR | N | N |
| Paquin et al., 2020 | Y | Y | NR | NR | N | Y | Y | Y | Y | Y | Y | NR | N | N |
| Sharp et al., 1995 | Y | Y | Y | NR | N | Y | Y | N | Y | Y | Y | NR | Y | N |

*Notes*. Asterisk indicates that this criterion is noted in the cohort profile paper of the given study. N = no, NR = not reported, Y = yes.

**Figure S1**. Funnel plot of publication bias

Cognitive outcome (SD Units)

**Table S6**. Meta-regression analysis of effect sizes by time of exposure to maternal depression

|  |
| --- |
| ***Boys*** |
|  | k | Hedges’ *g* (95% CI) | I2 | b | SE | t | p |
| Ante | 2 | -0.25 (-1.58 to 1.07) | 0% | -0.24 | 0.11 | 2.17 | 0.137 |
| Post | 10 | -0.40 (-0.73 to -0.08) | 83% |
| ***Girls*** |
| Ante | 2 | -0.08 (-0.90 to 0.75) | 0% | -0.13 | 0.22 | -0.59 | 0.862 |
| Post | 10 | -0.19 (-0.48 to 0.11) | 96% |

*Notes*. *b* represents the difference in meta-analytic effect sizes between the early (0) and late (1) groups; *95% CI* represents the 95% confidence interval of the effect size; *k* represents the number of effect sizes. Ante = maternal depression assessed during pregnancy; Post = maternal depression assessed after child’s birth

**Table S7**. Meta-regression analysis of effect sizes by method of measuring maternal depression

|  |
| --- |
| ***Boys*** |
|  | k | Hedges’ *g* (95% CI) | I2 | b | SE | t | p |
| RS | 6 | -0.16 (-0.36 to 0.04) | 78% | -0.70 | 0.14 | -4.94 | 0.005 |
| DI | 6 | -0.84 (-1.23 to -0.44) | 28% |
| ***Girls*** |
| RS | 6 | -0.24 (-0.72 to 0.24) | 98% | 0.17 | 0.20 | 0.85 | 0.445 |
| DI | 6 | -0.10 (-0.29 to 0.09) | 0% |

*Notes*. *b* represents the difference in meta-analytic effect sizes between the early (0) and late (1) groups; *95% CI* represents the 95% confidence interval of the effect size; *k* represents the number of effect sizes. DI = diagnostic interview; RS = rating scale.

**Table S8**. Meta-regression analysis of effect sizes by child age category at cognitive assessment

|  |
| --- |
| ***Boys*** |
|  | k | Hedges’ *g* (95% CI) | I2 | b | SE | t | p |
| Child | 6 | -0.36 (-0.77 to 0.05) | 77% | 0.21 | 0.13 | 1.54 | 0.201 |
| Adolescent | 6 | -0.40 (-0.89 to 0.09) | 81% |
| ***Girls*** |
| Child | 6 | -0.16 (-0.44 to 0.11) | 0% | 0.09 | 0.18 | 0.50 | 0.640 |
| Adolescent | 6 | -0.23 (-0.77 to 0.30) | 97% |

*Notes*. *b* represents the difference in meta-analytic effect sizes between the early (0) and late (1) groups; *95% CI* represents the 95% confidence interval of the effect size; *k* represents the number of effect sizes. Adolescent = defined as 11 to 18 years; Child = defined as birth to 10 years.

**Table S9**. Meta-regression analysis of effect sizes by length of time between assessments of maternal depression and cognitive outcome

|  |
| --- |
| ***Boys*** |
|  | k | Hedges’ *g* (95% CI) | I2 | b | SE | t | p |
| Short | 4 | -0.16 (-0.65 to 0.33) | 76% | -0.18 | 0.13 | -1.37 | 0.245 |
| Long | 8 | -0.52 (-0.91 to -0.13) | 83% |
| ***Girls*** |
| Short | 4 | -0.24 (-1.22 to 0.74) | 97% | 0.07 | 0.29 | 0.26 | 0.890 |
| Long | 8 | -0.17 (-0.27 to -0.08) | 0% |

*Notes*. *b* represents the difference in meta-analytic effect sizes between the early (0) and late (1) groups; *95% CI* represents the 95% confidence interval of the effect size; Long = defined as more than 12 months; Short = defined as 12 months or less.