INPLASY

Speckle-Tracking Echocardiography for Assessment of Left Ventricular Strain Alterations in Women with Hypertensive Disorders of Pregnancy: A Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - No support.

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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 18 August 2026 and was last updated on 18 August 2026.

INTRODUCTION

Review question / Objective To systematically evaluate left ventricular myocardial strain alterations in women with hypertensive disorders of pregnancy (HDP) compared with normotensive pregnant controls using speckle-tracking echocardiography.

Condition being studied Hypertensive disorders of pregnancy (HDP), including gestational hypertension, preeclampsia (PE) and chronic hypertension with superimposed PE.

METHODS

Participant or population Pregnant women diagnosed with HDP per American College of Obstetricians and Gynecologists and International Society for the Study of Hypertension in Pregnancy guidelines.

Intervention left ventricular mechanics assessed by two-dimensional (2D) or three-dimensional (3D) STE.

Comparator normotensive pregnant controls.

Study designs to be included The search combined MeSH terms and keywords across four domains: (1) HDP, (2) echocardiography, (3) speckle-tracking techniques and (4) left ventricular strain parameters (GLS, GCS, GRS). Reference lists of included studies and relevant reviews were manually screened for additional eligible publications. No language restrictions were applied.

Eligibility criteria Inclusion Criteria
Studies were included if they met the following criteria based on the PICOS framework: (1) Population: pregnant women diagnosed with HDP per American College of Obstetricians and Gynecologists and International Society for the Study of Hypertension in Pregnancy guidelines; (2)

Exposure: left ventricular mechanics assessed by two-dimensional (2D) or three-dimensional (3D) STE; (3) Comparison: normotensive pregnant controls; (4) Outcome: reporting of GLS, GCS or GRS as mean ± standard deviation (SD); (5) Study design: case–control, cross-sectional or cohort study; and (6) Timing: echocardiography during pregnancy or within 7 days postpartum. No language restrictions were applied.

Exclusion Criteria

Studies were excluded if they met any of the following conditions: (1) incomplete reporting of outcome data such that mean ± SD could not be extracted or reasonably derived via validated estimation methods, (2) studies with a sample size smaller than 10 participants and (3) duplicate publication of data from the same study cohort (in such instances, only the publication reporting the most complete or most recent data was retained).

Information sources Two investigators independently extracted the following information from each included study: (1) included study (first author and year of publication), (2) study design, (3) country, (4) sample size of the case and control groups, (5) age of the case and control groups, (6) gestational age at echocardiographic examination for the case and control groups, (7) blood pressure values for the case and control groups, (8) participants (i.e. the clinical definitions of the case and control groups), (9) the exposure or intervention condition of the case group, (10) the control condition of the control group and (11) the reported left ventricular strain outcome measures, specifically the mean and SD of GLS, GCS and GRS. All numerical values were extracted directly from the original publications. For studies reporting only regression coefficients or incomplete outcome data, the corresponding authors were contacted via email to request the original data. Disagreements were resolved through discussion with a third investigator.

Main outcome(s) reporting of GLS, GCS or GRS as mean ± standard deviation (SD); study design: case–control, cross-sectional or cohort study; and timing: echocardiography during pregnancy or within 7 days postpartum.

Quality assessment / Risk of bias analysis The risk of bias in each included study was independently assessed by two investigators using the Newcastle–Ottawa Scale (NOS). Although Ilić A was designed as a prospective cohort study, the baseline GLS data used for comparison in this metaanalysis were crosssectional in nature, with the exposure and control groups assessed at a single time point. Consequently, the NOS for case–control studies was applied to evaluate the risk of bias for this specific exposure–outcome relationship, ensuring that the assessment tool was aligned with the structure of the data being analysed. For the 12 case–control studies and the single cohort study that reported baseline data in a cross-sectional manner, the NOS for case–control studies was applied, which evaluates three domains comprising eight items: Selection (adequacy of case definition, representativeness of cases, selection of controls and definition of controls, with a maximum of 4 stars), Comparability (comparability of cases and controls in the design and analysis, with a maximum of 2 stars) and Exposure (ascertainment of exposure, same method of ascertainment for cases and controls and nonresponse rate, with a maximum of 3 stars). For the two cohort studies, the NOS for case–control studies evaluates Selection (four items, maximum of 4 stars), Comparability (maximum of 2 stars) and Exposure (three items, maximum of 3 stars). The NOS for cohort studies evaluates Selection (four items), Comparability (maximum of 2 stars) and Outcome (three items, maximum of 3 stars). The total possible score is 9 stars. Total scores ≥8 stars were considered high quality, 6–7 moderate and ≤5 low. Disagreements in scoring were resolved through discussion or by consulting a third investigator.

Strategy of data synthesis All statistical analyses were performed using Stata version 17.0. Given anticipated between-study heterogeneity arising from variations in strain measurement equipment, software algorithms and clinical characteristics of study populations, a random-effects model (DerSimonian–Laird method) was applied for all pooled estimates. The standardised mean difference (SMD) with its 95% confidence interval (CI) served as the summary effect measure for quantifying differences in left ventricular global strain between women with HDP and normotensive pregnant controls. The SMD was calculated by dividing the difference between the HDP group and control group means by the pooled SD, with correction for sample size. No algebraic transformation (e.g. conversion to absolute values) was applied to the originally reported strain values; the directionality of the SMD was determined solely by the arithmetic difference between the group means, ensuring consistency with the pathophysiological interpretation of myocardial dysfunction. For studies in which continuous outcome variables were reported as median with interquartile range rather than as mean ± SD, the methods described by Wan et al were applied to estimate the mean and SD, enabling inclusion in the pooled analysis. Heterogeneity was assessed

qualitatively using the Cochran Q test with a significance threshold of P < 0.10, and quantitatively using the I^2 statistic; I^2 values range from 0% to 100% and were interpreted according to the following classification: 0%–25%, low heterogeneity; 25%–50%, moderate-low heterogeneity; 50%–75%, moderate-high heterogeneity; and above 75%, high heterogeneity.

Subgroup analysis To explore potential sources of heterogeneity, prespecified subgroup analyses were conducted stratified by clinically and methodologically relevant variables: (1) disease subtype (HDP group vs PE group) and (2) gestational age at echocardiographic assessment (i. latepregnancy assessment group: studies in which the mean or median gestational age at echocardiography was ≥34 weeks, or the examination was explicitly conducted during the late third trimester [≥28 weeks]; ii. earlyonset assessment group: studies in which all participants or a clearly defined subgroup underwent echocardiography before 34 weeks of gestation and for which data were reported separately; and iii. peripartum/predelivery assessment group: studies in which echocardiography was performed immediately before delivery or within 1 week postpartum without a specific gestational age threshold being applied). Pooled SMDs with their corresponding 95% CIs were reported separately for each subgroup.

Sensitivity analysis Leave-one-out sensitivity analysis was performed to evaluate the influence of each individual study on the overall pooled estimate by iteratively removing 1 study at a time and repeating the meta-analysis for the remaining studies. For outcomes including 10 or more studies, publication bias was assessed by visual inspection of funnel plot symmetry together with Egger's linear regression test; for outcomes with fewer than 10 studies, funnel plots were provided for qualitative description only, and formal testing was not performed. Finally, the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework was applied to rate the overall certainty of the evidence for each outcome. All statistical tests were two tailed, and P < 0.05 was considered statistically significant.

Country(ies) involved China - The Second People's Hospital of Liaocheng.

Keywords hypertension; pregnancy-induced; pre-eclampsia; echocardiography; global longitudinal strainhypertension.

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